

1990 AASHTO ANNUAL MEETING PROCEEDINGS

**Selected Committee Meeting Papers
Presented at the Seventy-Sixth Annual Meeting of the
American Association of State Highway and
Transportation Officials in Phoenix, Arizona
December 10-11, 1990**



**Published by the American Association
of State Highway and Transportation Officials
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OPENING GENERAL SESSION

76th Annual Meeting of the American
Association of State Highway
and Transportation Officials
Phoenix, Arizona
December 10, 1991

Remarks of SENATOR STEVE SYMMS

*Ranking Minority Member
of the Subcommittee on Water Resources,
Transportation and Infrastructure of the
Senate Environment and Public Works Committee*

Thank you, Kermit, President Justice, and all the members of AASHTO, for honoring me with the 1990 George S. Bartlett award. I am proud and gratified to be listed among the recipients of this most prestigious award, and I am particularly pleased my friend, Kermit Kiebert, could be here to present it and say all those nice things about this Senator from the other side of the political aisle. Kermit and I leave ourselves open to the suspicion of our partisan friends at home by working so closely together on the highway program. But I truly appreciate that working relationship and want to thank you all for allowing my friend to present the award today.

It is fitting, for my purposes at least, that your annual meeting is being held here in Arizona where, as in Idaho and other western states, there can be no doubt about the importance—the absolute necessity—of a good highway system. Without our network of Interstate and primary highways built to modern engineering standards, travel to most destination points in this part of the country would re-

quire days or weeks away from home, and productivity in much of our commerce and industry would slow to a fraction of current levels. We in the West are a transportation—and specifically, highway—dependent people, and that means the marketplaces of the East and Pacific Coast states are also transportation dependent because the nation's food and raw goods come from middle America.

“...there can be no doubt about the importance—the absolute necessity—of a good highway system.”

It was the vision and political strength of President Eisenhower that brought us not only this 42,798-mile system of interstate highways—thought too fantastic to be believed when Ike first proposed it in his State of the Union address in January, 1955—but

that also brought us the Highway Trust Fund, the highway user fees that support it, and what I like to call the "pay-before-you-go" system of financing our federal-aid highway program. Ike's vision also made possible the federal/state partnership that has made the highway program the model of federalism at work.

This jewel of the Eisenhower Administration has served the nation well now for nearly 35 years, and although our highway program may require some substantial modifications because the Interstate System is nearing completion, President Eisenhower's basic outline for financing and administering our highway program could continue to serve Americans well for many years to come. Unfortunately, just two months ago, Congress took a sledge hammer to the cornerstone of our highway program—the user fee principle—by approving, for the first time since 1956, a major increase in motor fuel taxes to accrue to the General Fund and expressly intended for non-transportation programs.

In my view, that action was a devastating blow to a program that has made possible economic growth across the country, required a new measure of our standard of living, and brought more personal mobility and freedom to Americans than any other federal program, except national defense, in our 200-year history. The durability of the federal-aid highway program depends on the willingness of motorists (and voters) to pay fuel taxes up front in return for a benefit they'll see later on in the form of highway improvements. I believe the voters' willingness to support those fuel taxes will be seriously eroded when they realize only a portion of their tax dollars are to be used in the highway program.

I fought against the fuel taxes in this year's budget agreement and only through a game of parliamentary dodge and parry were the Majority and Minority Leaders able to narrowly defeat my amendment. We lost that budget battle, but the war continues between those of us who want to preserve the user-paid, dedicated financing mechanism of the highway program and those who want to tear it apart so fuel taxes and the highway program be-

come just another part of the General Fund budget. We must—all of us in the highway community must—ensure that all fuel taxes incorporated in the 1991 highway bill are raised expressly and solely to accrue in the Highway Trust Fund and *be used* in the highway program.

"The durability of the federal-aid highway program depends on the willingness of motorists (and voters) to pay fuel taxes up front in return for a benefit they'll see later on in the form of highway improvements."

As it stands, the 2.5-cents per gallon tax now going to the General Fund means a loss of approximately \$3 billion to the Highway Trust Fund. Over the five years for which taxes in the budget agreement have already been approved, we will lose more than \$15 billion in fuel taxes (about one year's worth of highway spending at current program levels) going to non-transportation expenditures. Those are highway user fees that will never, ever be retrieved for use in the highway program. Given the unmet highway needs in every state in the Union, that is a loss of revenue we cannot and should not sustain. In addition to the adverse effect on the federal-aid program, of course, it is also a big bite out of the tax base most of you rely on to support your own state highway programs, and again, this bite is being consumed by non-transportation interests, so not only can you not raise the money locally but you won't see it returned from the Feds, either.

Let us commit ourselves here, at this meeting, to ensuring the 1991 highway bill will renew the integrity of the user fee principle by committing all motor fuel taxes to the Highway Trust Fund. If all of you will help me and my colleagues on the Public Works Committees, I believe we can get the job done and repair the foundation of our federal-aid highway program.

As a parting word of warning, please don't use the rhetoric of the Budgeteers by referring to the 2.5-cents going to the General Fund as a "deficit reduction" tax. Fuel taxes score for deficit reduction in the Highway Trust Fund just like they do in the General Fund. The difference is this: if all the fuel taxes go into the Trust Fund, the ledger balance in the Trust Fund would grow at an alarming rate. *Maybe* so alarming that Congress would be forced to increase spending in the highway program to draw down that balance. This is the situation those on the other side of the "gas-tax-for-deficit-reduction" debate want desperately to avoid. So call the General Fund fuel taxes what they really are: highway use taxes collected for non-transportation programs.

The highway program can and will contribute to deficit reduction by making possible increased productivity, economic growth, jobs, and a larger tax base. We can and should increase spending in the program, even well above the \$2.3 billion increase approved in the 1991 Transportation Appropriations bill. Otherwise, by the end of fiscal 1994, even

without retrieving the 2.5-cent General Fund fuel taxes, the cash balance in the Highway Account will grow to \$19 billion.

"So call the General Fund fuel taxes what they really are: highway use taxes collected for non-transportation programs."

Given our highway funding needs, that is an irresponsible and unacceptable program. Ladies and gentlemen, with your help next year, we can put fuel taxes back to work on improving our highways and bridges and preserve the integrity of a transportation program that has served Americans well for two generations.

Again, I want to thank you for honoring me with the George S. Bartlett award, and I look forward to working with all of you next year.

OPENING GENERAL SESSION

Remarks of

NORMAN MINETA

*Chairman, Subcommittee on Surface Transportation
of the House Committee on Public Works*

It is a distinct honor to be here with you today to participate in the annual meeting of the American Association of State Highway and Transportation Officials. After the long and turbulent closing days of the 101st Congress, I welcome the opportunity to resume discussions about important transportation matters in a calmer atmosphere.

With the elections now behind us and with the budget debate still ringing in our ears, I believe we must respond to the mandate of the American people to return to Washington and make tough decisions.

As all of you may have heard, when I returned to Washington last week many of my colleagues approached me with deeply felt concerns about the effectiveness of the Committee on Public Works and Transportation. In fact, a majority of my Democratic colleagues on the committee made the case to me that there were problems for which new leadership was the only solution.

Upon reflection, I came to agree with their assessment, and that is why I decided to seek the Chairmanship of the Public Works and Transportation Committee.

The Democratic Caucus ultimately chose to elect the second most senior member of the Committee, Congressman Bob Roe from New Jersey, as the new

Chair of the Committee on Public Works and Transportation. I look forward to working with him to structure legislation for the reauthorization of the surface transportation programs.

“The most important piece of legislation to be considered in the next Congress will be the reauthorization of the surface transportation programs.”

Before launching into the Subcommittee on Surface Transportation’s plans for the 102nd Congress, I would like to review what we have done during the 101st Congress and how these accomplishments represent the first steps towards the visionary transportation agenda the U.S. will need for the 1990’s.

The Subcommittee played a significant role in the development and passage of two major pieces of legislation: namely, the Clean Air Act and the Americans With Disabilities Act of 1990.

The Clean Air Act represents the first significant change in clean air legislation in more than a decade. The Americans With Disabilities Act gives

strong and long overdue recognition to the civil rights of millions of our fellow citizens.

I am very proud of the Committee's contributions to each of these landmark laws.

In addition, Congress approved two regulatory measures that will have profound effects on the transportation industry: the Sanitary Food Transportation Act; and The Hazardous Materials Transportation Uniform Safety Act.

Each of these were considered by the House Public Works and Transportation Committee, the House Energy and Commerce Committee, and the Senate Commerce Committee in closely coordinated efforts—and it was this coordination that led to legislative success.

In addition, the Motor Carrier Safety Act was signed into law by President Bush on November 3rd.

This law mandates the correction of safety violations by requiring random reinspection of trucks and drivers placed out of service. It mandates that the U.S. Department of Transportation establish procedures to take action against carriers committing serious violations. And finally, DOT will have to publish a list of motor carriers with unsatisfactory safety ratings.

Again, everyone wins. Industry gets shoddy carriers off the highways—which could reduce their insurance costs—and motorists benefit with safer roads.

With these important new laws on the books, it is now up to the 102nd Congress to complete a larger transportation agenda for the 1990's.

The most important piece of legislation to be considered in the next Congress will be the reauthorization of the surface transportation programs.

In the next few years, the United States will complete the world's greatest public works project: the National System of Interstate and Defense

Highways. As this occurs, our Nation will quickly arrive at a critical crossroads in the development of an entire transportation network of highways and mass transit systems.

"I strongly believe that we must look at our Federal transportation programs from a broader perspective than we have done in the past."

During the next 10 years, the discussion in Congress will focus on the future of our nation's more than 4 million miles of highways and bridges and its 438 mass transit systems.

The question is: What do we do with them?

How do we use them to the benefit of the American people, and to enhance the economic power we have here at home and throughout the world?

That's what we now need to decide—and soon, before we tempt fate by continuing to neglect our transportation lifeline, which is our link to a prosperous economy.

I strongly believe that we must look at our Federal transportation programs from a broader perspective than we have done in the past.

I believe we must define our efforts in terms of our international competitiveness, domestic economic development, quality of life, public safety, and providing flexible, consistent sources of funding.

Today, it is our economy which faces the most serious threat from an inadequate transportation system.

Today, we must play catch up ball and bring our roads, bridges and transit systems to where they should be—and then get ready for the 21st Century.

We know that the costs of meeting our transportation needs will be substantial, but think of the price the United States has already paid for being penny-wise and pound-foolish.

In the 1960's and 1970's, we spent more than 2.3 percent of our annual Gross National Product on our transportation network. In the 1980's, that level shrunk to four-tenths of one percent, leaving the United States 55th in the world in capital investment.

The result?

In the last 10 years, urban traffic congestion has increased nationally by 50 percent.

Half our nation's bridges are deficient or classified as functionally obsolete by the Federal Highway Administration.

"The simple truth is this. We must make investing in our transportation infrastructure a top national priority. Transportation programs must never again be underfunded as they have been in the recent past."

More than 60 percent of our roads are considered substandard; more than 1 million miles of pavement will have to be resurfaced by the year 2000.

Underfunding highway and mass transit programs may have made sense to some in the past for the sake of short-term fiscal relief.

Underfunding in the future, however, could mean economic suicide in a new world in which butter, not guns, is the preferred commodity.

The simple truth is this. We must make investing in our transportation infrastructure a top national

priority. Transportation programs must never again be underfunded as they have been in the recent past.

In the 1990's, I believe the key to finding solutions to our Nation's transportation problems will be to define the appropriate Federal role.

"Now, more than ever, it is vitally important that we begin to spend aviation trust fund monies if we are to adequately provide for much needed modernization and capital development."

I believe that Federal role must take into account state and local needs, program flexibility, and the right of people who have paid taxes into the transportation trust funds to get what they've paid for, and not see those funds idle away at the same time the Federal gas tax is increased by 5 cents.

Of that 5-cent increase, only half goes to the Highway Trust Fund, with 80 percent for highways and 20 percent for mass transit. But, and this is a very major but, we have been unable to secure a commitment that those funds will ever be spent in the next 5 Fiscal Years for transportation improvements.

Believe me, I will continue my fight to guarantee first, that we get to spend the 2-1/2 cents that will be deposited in the Highway Trust Fund for our road and transit infrastructure.

Second, I will work to recoup that other 2-1/2 cents, which is slated for deficit reduction through Fiscal Year 1995, for the traditional transportation purposes associated with the Federal gas tax.

Third, I won't forget the current balances in the Highway Trust Fund and its Mass Transit Account. We must secure adequate obligation ceilings in the future to spend down the balances as well as the

revenues generated by the gas tax increase contained in the budget summit agreement.

The same bill that raised the gas tax included an increase in the airline passenger ticket tax. And even though I no longer chair the House Subcommittee on Aviation, I won't forget the 7 billion dollar surplus in the Airport and Airways Trust Fund. Now, more than ever, it is vitally important that we begin to spend aviation trust fund monies if we are to adequately provide for much needed modernization and capital development.

Recent months have been especially hard on the airline industry. Any discussion of long-term infrastructure needs must include Federal aviation policy and airport and airway development goals. The decisions that we make during this next year promise to address some of the most important transportation issues of the decade. The Administration must acknowledge these needs and spend down the aviation trust fund. Anything less is short-sighted.

Also, we must increase the ridership on our transit systems if we are going to reduce congestion. During the 1980's, transit programs lost more than 50 percent of their purchasing power from outright budget cuts and inflation. Transit systems cannot be expected to continue to provide cost-effective, quality service while deferring maintenance and increasing fares.

Of course, I have already pointed out the extraordinary irony of amassing huge surpluses in the Highway Trust Fund while transportation needs go unmet. We must immediately begin the coalition-building process needed to restore funding for transit programs.

The recent passage of the Clean Air Act amendments also increased the importance of transit as a transportation pollution control measure. Yet, to achieve real progress, we must attack air pollution on a broader front. In addition to increased transit ridership, we must promote carpooling, vanpooling, and other shared ride programs. An employee is much more likely to use public transit if that employee knows that he or she has an employer-pro-

vided ride home if working late results in a missed bus or train.

"We must begin to view transit in the broader context of providing a menu of interrelated alternatives to the single-occupant automobile trip."

Similarly, an employee is much more likely to carpool or vanpool if a transit ride can get that employee home if he or she works late and misses the carpool or vanpool.

We must begin to view transit in the broader context of providing a menu of interrelated alternatives to the single-occupant automobile trip. Only then will we begin to seriously address the dual challenges of reducing congestion and cleaning up our dirty air.

But the Public Works and Transportation Committee cannot address the Nation's transportation problems alone. Your help is essential if we are to move the Budget and Appropriations Committees and the Congressional leadership.

As far as the appropriate Federal role, I wish I could say that I support the Administration's National Transportation Strategy when it comes to highways and mass transit—but I can't.

The strategy proposes to redefine the Federal role for maintaining the Nation's transportation systems by transferring a greater burden of financial responsibility to state and local governments.

This is the wrong way to go.

My concern with a decrease in the Federal financial role focuses on those states and localities, like California, that are today providing significant levels of local and state support for transportation programs.

Extraordinary commitments of state and local resources through sales taxes, assessment districts and other revenues are admirable and should be encouraged.

Yet the National Transportation Strategy does just the opposite. It says, 'Localities, make your commitments under Federal guidelines—then the Federal Government will reduce available monies.'

This fiscal mentality would hurt everyone, but especially those cities, counties and states that do not have adequate local resources to fill the void created by the withdrawal of or reduction in Federal transportation funds.

"Our transportation network is the most expansive in the world. Being the biggest does not mean we're the best."

Make no mistake. Our transportation network is the most expansive in the world. Being the biggest does not mean we're the best. We should be the best and we should settle for nothing less.

Studies call for transportation investments of up to \$3 trillion during the next 20 years. We can differ about the final cost, but to me there is no more universal truth than this:

How we spend the money is as important if not more important than how much money we spend.

One of my chief objectives in reformulating Federal transportation programs is to ensure that Federal-aid does not become a roadblock to our cities, counties, transit agencies, and states in their efforts to meet transportation needs.

For example, in my Congressional District which covers portions of San Jose and Santa Clara County, California, local officials and the State Department of Transportation need to determine and implement the best solution. They need to determine whether

that means using Federal funds to upgrade freeways, extend light or heavy rail, or add car pool lanes in the urbanized area.

The same is true for the Nation as a whole. States and localities, not the Federal Government, are in the best position to identify the best mix of transportation improvements for your cities and the surrounding areas.

In identifying a highway system of national significance, the Committee needs to establish criteria that focuses clearly on a national transportation network.

In the past, Federal expertise has been misapplied and local decisions second-guessed in Washington, D.C. That serves no one. One great hope I do have for the future is that our redesign of Federal transportation programs will include a decision-making process which avoids this pitfall.

During the next nine months, the Subcommittee on Surface Transportation will develop legislation that will carry us well into the 1990's. Our focus—now and in the future—will be on maintaining the Federal investment in the Federal-aid highway system, on continuing broad Federal support for mass transit, and on creating a partnership that will include Federal, state, and local governments, as well as the private sector.

"In identifying a highway system of national significance, the Committee needs to establish criteria that focuses clearly on a national transportation network."

You are all key players in the process. I ask you to let your Senators and Representatives know of your concerns. They need to hear from you before they hear from me. You will be among those calling the shots for the Nation. We need your help to build the transportation network we all want and need.

We need your help to develop not a single strategy, but a series of policies that will be responsive to respective state and regional needs and will carry

us and our prosperity into the next century. We can afford nothing less.

OPENING GENERAL SESSION

Remarks of

SAMUEL K. SKINNER

*Secretary of Transportation,
U.S. Department of Transportation*

Good morning. You could not have picked a more appropriate city for this year's annual meeting. Just three months ago today, right here in the heart of Phoenix, the final link in Interstate 10 was opened, joining Florida and California.

Completing I-10 was an important milestone in America's march into the future. It marks one of the final steps in completing the vast 43,000 mile Interstate Highway System that has unified America.

It's critical that we remember—particularly on the eve of the 1991 surface reauthorization process—that this tremendous achievement did not occur without a vision. Nor did it happen without the unity of differing parties rallying around a common quest. And it wasn't accomplished without a lot of plain hard work.

To your great credit, the task of finishing the Interstate Highway System is virtually over. Our task today is—in its own way—just as vital to the nation as the one President Eisenhower inaugurated 34 years ago. Today, however, we face a different set of challenges.

In 1956, "global competitiveness" was not in the nation's vocabulary. Back then, America was on top of the world. We were far and away the world's largest creditor nation. "Trade deficit" was practi-

cally an unknown term. The United States imported \$12.6 billion worth of goods and services. We exported \$17.3 billion. Back in those days, "Made in Japan" was a term of derision. Today, it's a symbol of quality.

Clearly, we live in a different world. And with it comes a different set of challenges, and the need for a different vision. That's what I'd like to talk to you about today. We in transportation, particularly in so vital an area as transportation infrastructure, face the need for a new vision for a new world.

In many ways, next year's surface transportation package will set the course of the nation's entry into the 21st century. There will be, and should be, a vigorous debate. We know that. Yet we cannot squander the opportunity before us. The stakes are too high. They're too high for each of you in your respective states, and they're too high for America's competitive standing in the world.

Without a comprehensive strategy to repair, maintain, and expand America's crumbling infrastructure, along with the legislative package to back it up, I don't see how America can compete in the global marketplace of tomorrow. Consider these facts. Investment in our nation's physical capital has fallen from 24 percent of federal outlays in 1960 to 11 percent in 1990.

Historically, America's strength rested in the vigor of its research and development, and in its vast infrastructure of railroads and highways and airports that kept our economy on the move. What would America's pioneering spirit have been—where would America be today—without the tremendous commitment of the past to infrastructure and research and development?

Can we sustain the commitment we need into the future? Several studies, including some commissioned by AASHTO, demonstrate just how hard this will be. They show that it'll cost a minimum of \$38 billion a year, and as much as \$83 billion a year, to meet the requirements for *capital* investment in our transportation system. The high end of this range is about twice the current level of spending.

As the backbone of America's economic strength, transportation has a direct bearing on U.S. productivity. And our sluggish growth in productivity compared to other nations should spur us to action as never before.

Think of the times we're living in: The Iron Curtain has fallen, opening up the markets of eastern Europe for the first time in decades. Europe 1992 is fast becoming a reality. Germany is united. Russia is moving toward a market economy, and last week actually encouraged ownership of private property. Our competitors along the Pacific Rim appear as strong as ever.

We expect to open up free trade talks with Mexico soon. I was in Mexico last week and discussed important transportation issues with Caso Lombardo, Mexico's Secretary of Communications and Transport. We signed a Memorandum of Understanding, and found ourselves in general agreement on lifting barriers that hinder transportation services between our countries.

I also met with President Carlos Salinas. And I now understand why President Bush holds him in such high regard. He is truly a man on the move. I'll give just one example. He built a toll road from Mexico City to Taluca—from contract to completion—in less than one year. Mexico has almost

2,500 more miles either under contract or out for bid. And President Salinas is open to U.S. resources and expertise.

Whether in Mexico or on the other side of the globe, world circumstances present tremendous *opportunities* for the U.S. highway industry—an industry comprised of more than 40,000 companies and manufacturers employing almost a million workers. Recent international developments may also represent a tremendous *challenge*. When these countries and others expand and improve their transportation infrastructures, they will become even stronger competitors in the global market.

For America, the equation is clear. Investment in infrastructure equals economic competitiveness abroad, and growth and productivity at home. Failure to invest in infrastructure equals economic decline. We simply cannot allow a deteriorating U.S. infrastructure to threaten our economy and our international competitiveness at this time.

That's the fundamental reason we produced the National Transportation Policy in the first place. We needed a strategic blueprint to help *move* America into the global economy of the future. No major enterprise can successfully tackle the future without a strategic vision. The same holds true for the U.S. Department of Transportation and its partners, especially those of you in AASHTO.

As soon as our National Transportation Policy was in place in March, the Department moved immediately into what we call NTP Phase 2. This phase, which is ongoing, is aimed at building and restructuring DOT as an institution so that it will have the organizational strength to deliver what the NTP promises.

The first steps involved a careful examination of the Office of the Secretary, and its leadership role within the Department. I directed Tom Larson to do the same with the Federal Highway Administration. I asked him to explore the viability of reorganizing the Washington headquarters and to consider new ways of structuring our regional organization to better deliver our program to you. Beginning next

year, we'll be sending some of our federal highway officials to the Harvard Executive Program for state and local officials to help them become more attuned to your needs.

Have our efforts borne fruit? Absolutely. Based on the strategic framework of the National Transportation Policy, and our mobilization work at the Department, we achieved a resounding victory this year in reauthorizing the Federal Aviation Act. That victory is very important for those of us here today, and for the major task we have ahead of us next year.

The success of aviation reauthorization demonstrates that, with hard work and unity, we *can* deliver on the NTP vision. I know the same approach will work for surface reauthorization. But let me tell you up front something you already know: Our success will depend on the degree to which we forge a genuine partnership among all parties—the Administration, Congress, state government, trade associations, and industry—including rail and trucking.

This year's aviation reauthorization process proved that various interests can work together to produce something good for all parties. When we put our first draft on the table nobody liked it. If there was any agreement on any phase of that bill, I cannot recall it.

So take heart. What we accomplished in aviation, we can do for surface transportation if, and only if, all parties can set aside parochial concerns and work together for the common good. It worked in aviation. In the end, all major trade associations supported the final bill. In fact, it proved to be the most significant and comprehensive aviation legislation since deregulation.

There's no question that surface reauthorization will be harder next year. States, cities, contractors, transit authorities, safety groups, truckers, railroads—they all have their own agendas. What we cannot afford is the kind of potential battle lines being drawn by the rail and trucking industries against each other. Competition between these great

industries is healthy, but open warfare would not be good for the economy.

But I'd like to make one thing clear at the outset: It is not my job to referee this debate, or any other debate next year involving differing parties. My job is to make sure that the end result is in the best interest of the public and America's competitive standing in the world economy. That ought to be the goal of *everyone* with a major stake in surface reauthorization. If so, we'll achieve our goal.

I'm optimistic. DOT and AASHTO have a long and proven partnership. In the past, whenever we asked for your support, you delivered. Now another moment of truth as come. Our partnership will be tested in the months ahead. We have to put differences aside, and take hold of the unique opportunity before us. Frankly, I need your help. This country needs your help. We at the Department know very well that we cannot move forward successfully without AASHTO as a close partner.

With broad support from the states and within Congress, we came out well in October's budget agreement. Our obligation ceiling was set at \$14.5 billion—a 19 percent increase. That should get a lot of projects rolling that otherwise would have been delayed. We achieved a major increase in funding for Intelligent Vehicle Highway System research—from \$2.3 million in 1990 to \$20 million to fiscal 1991.

The federal gas tax that went into effect 10 days ago will raise an extra \$12.5 billion for the nation's highways over the next five years. After that, we should look forward to a "return to the dedicated user fee principle as soon as possible," as a "Sense of the Congress" resolution states.

Looking forward, we have prepared a good agenda for reauthorization. As we move into the post-interstate era, we will build on the present structure of the state-federal highway partnership.

As a centerpiece, we intend to propose the concept of a national highway system. Our current work on a National Highway System springs in part

from AASHTO's earlier efforts. This is an excellent example of the kind of partnership we need across the board as we march forward together to begin the surface reauthorization process.

We will look at various criteria and objectives regarding mileage levels in each state. We will move to decouple apportionments from designated mileage. We will call for some transferability between funds for Highways of National Significance and our flexible rural-urban program, but with ample safeguards to protect our investment in the existing interstate system.

This time around, we are attempting to cast reauthorization in a new mold. We want state and local authorities to have greater flexibility in the use of transportation funds at all levels of government and in alternative modes. For instance, using federal highway funds for toll road construction and mass transit could lead to more efficient ways of attacking congestion.

To that same end, we need to improve the linkage between transportation, development, and land-use

planning. It is essential that we continue to strengthen our overall multi-modal transportation planning and integrate our efforts with those at the local level.

Private sector investment can be encouraged through such alternative financing methods as tax districts and developer participation. Much greater weight will be placed on meeting the need for clean air.

While it's too early to spell out details, all in all the reauthorization process is proceeding on track. When we hit the ground running next year, we'll be prepared to march forward in an AASHTO-DOT partnership forged over 75 years of cooperation and trust.

You have been very fortunate to be under the able stewardship of Kermit Justice this past year. Tomorrow, he will pass the baton on to Hal Rives of Georgia for the crucial year ahead. I've very much enjoyed working with you, Kermit, and I'm looking forward to a productive year working with your worthy successor—for the benefit of AASHTO, the Department of Transportation, and the country.

OPENING GENERAL SESSION

Remarks of

WALLACE G. WILKINSON

*Governor of Kentucky,
Chairman, Committee on Transportation,
Commerce, and Communication of the
National Governors' Association*

President Justice, Congressman Mineta, Secretary Skinner, Senator Symms, ladies and gentlemen. It is a pleasure to join such a distinguished group of speakers—all key players in surface transportation.

Having been Governor now for three years I have concluded that despite all the various issues and programs we deal with in state government, nothing gets people more excited than a new road or more irritated than an old pothole. Former Speaker Tip O'Neill was fond of saying "all politics is local." Well, there's nothing more local than the road in front of your house.

Providing our citizens with a safe, efficient means of getting children to school and goods to market is a fundamental responsibility of government. And yet, as we are meeting today there are unpaved roads in this nation that have state numbers on them. And there are bridges that won't bear the weight of a loaded school bus. Airports are under pressure as traffic increases. An aging transportation infrastructure in some parts of the country is deteriorating to the point that it threatens public safety.

Despite all these challenges, we still have the best highway system in the world. We still have

mass transit systems that are capable of moving hundreds of thousands of people daily. We're still building new roads and we're still able to fix potholes, at least most of them anyway. Considering the various needs government must fulfill, we have done a remarkable job in transportation. With Secretary Skinner's comprehensive transportation plan and the efforts of public officials at all levels, I am confident that we will find the way to continue to maintain and improve transportation in America.

I come here today to pay my respects to you and to the tremendous contributions that you make to our everyday lives. You are on the firing line every day and we appreciate your dedicated public service. How tough is your job? So tough that in Kentucky no Secretary of Transportation had ever served for more than one thousand and thirty days (1,030) until Kentucky's Secretary Milo D. Bryant passed that milestone a few weeks ago. Think about that for a minute. It means that no Secretary of Transportation had ever served through any Kentucky Governor's entire four year term.

In the three years Milo has served we've been able to do some remarkable things in Kentucky. If you will indulge me for a moment, I want to share them with you because it shows what can be done when we set priorities and enthusiastically pursue

our goals. In our first budget (which by anyone's standards was a lean one) we had the largest rural road resurfacing budget in our history. We exceeded that goal in our second budget. We are currently in the process of replacing every bridge in Kentucky less than fifty feet in length that won't bear the weight of a loaded school bus. In the 1990 session of our general assembly, we passed a \$600 million road bond to build roads that have been needed in Kentucky for twenty years. Secretary Bryant assures me that by the end of my term in office one year from now we will have paved every gravel road that still has a state number.

I know every one of you is as creative and committed as Milo. You have to be since transportation is the agency in state government that says "no" the most. For every road that we build there are others not yet underway. By the time we replace the bridges currently in the budget, others will be in need of repair or replacement. Fix one pothole and ten others are on the horizon. So if we fight for every dime we can get, if we lobby for all the money we can invest in infrastructure, we are doing it with the realization that our needs will always exceed our abilities to fulfill them.

For the first time in a long time, we have something to celebrate this year. As you know, in "Project 15" the Governors asked for a \$15 billion federal highway obligation ceiling. That would have been a \$2.8 billion increase above last year.

We succeeded in getting \$14.5 billion. It will let us say "yes" just a little more often. It will let us put an extra \$2.3 billion to work:

- upgrading county roads and bridges so that fewer school buses have to stop at posted bridges while children walk across;
- preserving more miles of roadway, giving motorists a smoother ride on new "black-top"; and
- accelerating safety and capacity improvements to access highways that link communities to the stream of commerce.

But the main reason I wanted to be here today is *not* to congratulate ourselves for this year's highway funding victory. It is to emphasize *why* we succeeded and what we need to do *now*. We succeeded because we had a clear message. Because we took that message to the Hill and supported the efforts of Congressman Mineta and others. Because we took it to the White House with Secretary Skinner. And because we effectively used the power of the Governors' offices to make a difference.

Governors were unified in a nationwide, bipartisan effort to press our case with the Administration and Congress. We must continue this winning strategy next year. We can't kid ourselves. We won, but a year is all we've got. There are no guarantees for the future. It will take the strongest possible pressure to hold onto that funding level and to fight for the increases we need. Decisions on *next* year's budget request are being made right now.

Even holding the gain we made this year in spending authority is not enough. The Governors opposed the gas tax increase for deficit reduction but it passed and now we must make sure that we reclaim all the trust fund revenues for transportation purposes as they were originally intended. The bottom line is simple and our message is the same: put the trust back in the trust fund.

I'm here today to enlist *your* help in getting a strong and effective surface transportation bill—one that is responsive to the needs of the states—by the 1st of July in 1991.

This is one of NGA's top priorities. Our game plan is to make the case for early action by the White House to send a *good* bill to Congress. Then we'll turn our attention to the congressional committees. We all need to understand that the clock is ticking. That's why we are already working with the Governors and that's why I'm here today. If you get only one message from my remarks today, this is it: To be successful we must be determined and we must work together. United we stand, divided we fall. That happens to be the state motto of Kentucky. We'll loan it to you for this campaign.

The finest transportation system in the world grew out of a remarkable consensus on the need for a strong national program of highway improvement and the means to finance it. When President Eisenhower and the 84th Congress created the Federal Highway Trust Fund in 1956 the nation's Governors were full partners in the plan. The Governors agreed to give up a traditional source of state revenue—a portion of the gasoline tax—to be dedicated in trust for a valid national purpose—building and upgrading a national highway system that is owned and operated by the states.

In return, the federal government agreed to collect our money and return it for projects as needed for road improvements. But we've had problems enforcing that bargain. The money goes in, but it doesn't all come back out. If states are to continue this partnership, the federal government has to put trust back in the trust fund. We need a renewed commitment from Washington.

As you know, federal support represents only a portion of the total dollars the states spend on transportation. State and local governments now provide almost 80 percent—four out of every five dollars—spent on surface transportation in this nation. States and local governments contribute \$63 billion of the \$82 billion spent. And states provide substantial support to addressing local needs. In 1988, for example, state aid to local governments totaled \$143 billion compared to only \$20 billion in direct federal aid to local governments.

I'm here to say that we're paying our fair share already. Just so it's perfectly clear we want *no* change in matching rates. And we will accept no more mandates. We want the trust fund balance and all annual revenues, plus interest spent for their intended purpose and we want it starting *now*—not in five years!

Initial construction of the interstate system is nearing completion. As we enter this new era, we must refocus our priorities. Governors recognize that America's continued growth and competitive stature will depend upon transportation improvement programs that extend beyond construction of

the Interstate system. AASHTO has been a real leader within the transportation community in developing the "Consensus Transportation Program."

Through the National Governors' Association we have adopted a set of policy principles for surface transportation that focus on the "big picture," primarily economic and governance issues. The Governors will continue to strengthen our position as issues are raised for debate.

One of the issues to be decided is the size and structure of the new national highway system. My fellow Governors and I will expect AASHTO to develop a fair plan that takes care of the state interest. It is vital that states be chiefly responsible for designating the mileage. We think the system eligible for a high federal share probably should be closer to 200,000 miles than 150,000 miles. You need to talk with your Governor about the implications of this for your state.

Our first opportunity to talk with all Governors, including the new Governors, will be during the NGA winter meeting in Washington, D.C. It is being held earlier than usual next year, on February 3-5, about the time that the President's budget request will be announced. But, we can't wait until February to get started. Indeed, we want to take stock of progress by then and be prepared to kick off our congressional lobbying effort.

That's why I'm asking for your help today. We have a job to do. Prepare your Governor with facts and figures on the critical importance of early enactment of the surface transportation bill to your state. During the February meeting, your Governor should be prepared to do two things: first, work collectively with other Governors; and second, hold a special meeting with your congressional delegation to secure their help. You should initiate this discussion with your Governor as soon as you return from this conference.

During the NGA winter meeting, the focus of our Transportation, Commerce, and Communications Committee session will be to refine our strategy on the surface transportation bill. We will have

key congressional leadership join us for what I expect will be an important and spirited debate. Following the conference on February 5th, a group of Governors will meet with key members on the authorizing committees. Why don't you suggest that your Governor join me. We need a solid contingent to demonstrate the importance of getting a good bill enacted quickly.

But, that's just for starters. We must have a coordinated strategy to gain public support for improving transportation systems. AASHTO has an important public education effort underway to foster that awareness and promote the legislation. Awareness is growing. I am pleased that the public broadcasting system is developing a special program called "Coming and Going" to capture a wider audience and focus public attention on transportation.

At the federal level, the only way we will get action before summer is if the message comes through loud and clear this winter and spring. We are looking to you to initiate the essential grass roots support for transportation funding. Members of Congress must come to realize that their constituents are very concerned about funding transportation improvements. I tell people back home that it's important to know your local magistrates because you never know when you might need a

load of gravel. Congressmen and women are *our* magistrates and we must work closely with them to give them the information and support they need.

We must work with the private sector and community groups to ensure that the word gets out, that letters get written, that calls get made, and that action is taken by members of your delegation. If your legislators are not on the transportation committees, ask them to relay their concerns to their colleagues on those committees.

But don't rely exclusively on your delegation. Contact the committees directly. There's nothing worse than going to meet with a congressional committee and being told they aren't "hearing from anyone" on the matter. Don't hesitate to make that contact yourself. You can indeed make a difference. And, together, we can make a difference.

The challenges facing states today have never been greater and they are not going to get any easier. We simply must make the federal government live up to its responsibility for preserving and improving our nation's surface transportation systems. And we must redouble our efforts—starting right now—to get a bill adopted by July 1, 1991. Thank you for having me. Again, I salute your efforts and eagerly anticipate our work together.

ADMINISTRATIVE SUBCOMMITTEE ON FINANCIAL MANAGEMENT

of the Standing Committee on Administration

New Approaches to Strategic Financial Planning

SUZANNE H. SALE

*Division Director, Administrative Services Division
Arizona Department of Transportation*

Strategic Financial Planning

Background

- Transportation Environment Characterized by Growing Complexity and Change
 - Impacts of New Legislation
 - Funding Shifts
 - Energy Situation
 - Increasing Demands for New Facilities
 - Budget Constraints
- Implications for Decisionmakers
 - More Comprehensive Information Needed
 - New Techniques/Tools to Facilitate Financial Planning
- Government Agencies, Like Corporations, are Increasingly Turning to Computer Models and Enhanced Forecasting Techniques

Overview

- Systematic Approach to Looking Ahead

- Critical in the Formulation of Public/Private Policy
- Key Characteristics
 - Spans a Longer Time Horizon
 - Allows Examination of Alternative Futures
 - Links Planning With Budgeting
 - Is a Continuing Process
- Forecasts Represent the Cornerstone of the Planning Process

Forecasting in an Uncertain Environment

- Time-Series Techniques Have Proven Inadequate
- Traditional Forecasting has Limitations
 - High/Low Approach
 - Single Outcome
- Weaknesses With Sensitivity Analyses

- New Approaches
 - Econometric Modeling
 - Optimization Models
 - Risk Assessment

Characteristics of Effective Forecasting

- Stands Up to Critique (Peer Review)
- Is Based on Solid Assumptions
- Withstands Discontinuity

Navigating the 90's: Tools and Techniques

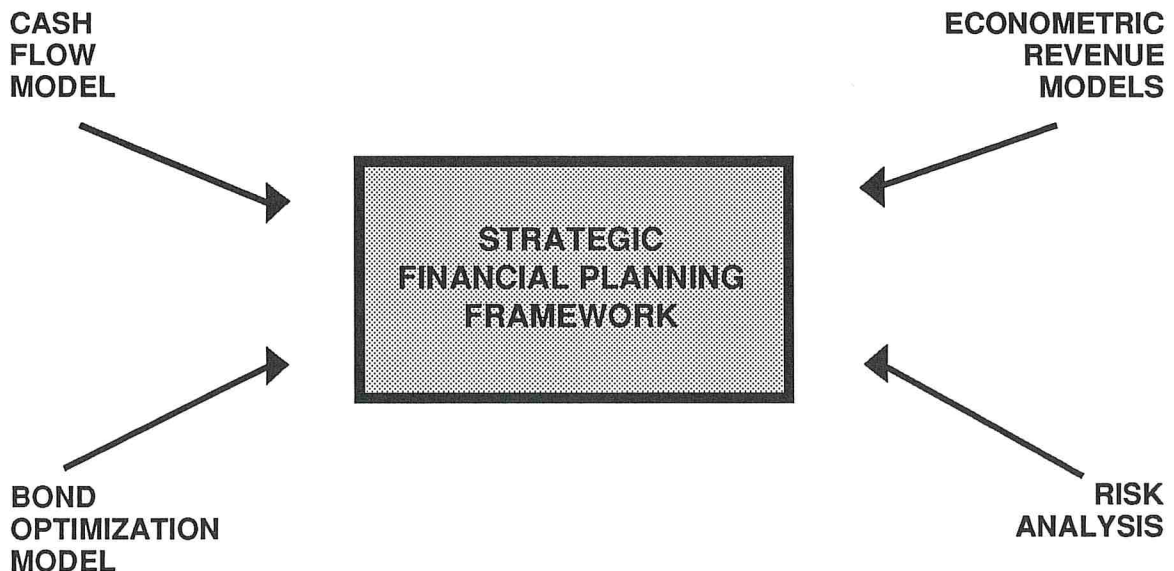
- Cash Flow Forecasting Models
- Econometric Models for Revenue Forecasting
 - Highway User Revenue Model
 - Transportation Excise Tax Model
- Bond Optimization Model

- Risk Analysis

Cash Flow Forecasting Model

- New System Enhances Short/Long Range Planning
- Provides Detailed Cash Flow at Funding and Project Phase Levels
- System Features
 - PC Based
 - Interfaces With Tracs
 - Curve Models
 - User Friendly/Menus
- Cash Flow Features
 - Control Fund Balances
 - Forecast Cash Available for Investment
 - Schedule Bidding of Contracts
 - Determine Fund Status
 - Plan Bond Issues

Figure 1



Highway User Revenue Model

- Regression-Based Econometric Model
- Structured Around Major Revenue Categories
- Dynamic in Nature
- Major Variables
 - Population
 - Personal Income
 - GNP
 - MPG
 - Gas Prices

Transportation Excise Tax Revenue Model

- Structural Econometric Model Developed in 1986
- Disaggregated Approach
- Model Variables
 - Personal Income
 - Population
 - Building Permits
 - Air Arrivals
- Coefficients Periodically Recalculated
- Restructured Version of 1986 Model Developed in 1989

Bond Optimization Model

- PC Based Spreadsheet Model
- Balances Revenues and Costs
- Input Variables Include
 - Revenues (All Sources)
 - Construction Requirements
 - Interest Rates
 - Debt Parameters

- Applications
 - Evaluation of Program Options and Changes
 - Development of Optimal Financing Programs
 - Maximization of Construction

Risk Analysis

The Process

- Recognized Interrelationships Between Variables
- Probabilities Assigned to Forecasting Assumptions
- Forecast Inputs Varied Simultaneously

The Results

- An Improved Forecast
- Quantification of the Probability that Forecast Attainable

The Benefits

- Builds Confidence and Consensus
- Involves Decisionmakers, the Public, and Stakeholders in the Process

Risk Analysis: ADOT Case Study

- Conducted as Part of the Strategic Planning Process for Maricopa Urban Freeway/Expressway Program
- Applied to Transportation Excise Tax Revenue Forecasts
- Process Integrates ADOT Econometric Models into Risk Analysis Format
- Consensus Forecasts Developed Using Expert Panel

RAP Step 1: Integration of Models into Software

- Structure and Logic Diagrams Developed
- Forecasting Approach Clearly Depicted
- Model Characteristics Programmed into Risk Analysis Software

RAP Step 2: Development of Central Estimates/Probability Distributions

- Variables/Coefficients Assigned Central Estimate and Range
- Central Values Derived from Model's Equations
- Probability Ranges Take into Account
 - Historical Trends
 - National Economic Forecasts
 - Regional/Local Demographics
 - Current Issues

RAP Step 3: Expert Evaluation and Consensus Building

- ADOT Session Conducted on October 18
- Eleven Economists Participated

- Panel Members Reviewed Assumptions—Provided Insights Regarding Economic Outlook
- Risk-Related Considerations Discussed and Analyzed
- Panel Members Prepared Data Sheets

RAP Step 4: Results

- RAP Software Transforms Ranges from Data Sheets into Probability Distributions
- End Product is Forecast with Estimates of Yield Probabilities

ADOT: Looking Ahead

- Formally Integrate Risk Analysis into the Strategic Framework
- Build In-House Expertise in the Process
- Apply Risk Analysis to Other Areas
- Continue to Enhance Forecasting Capabilities
- Maintain Proactive Approach

ADMINISTRATIVE SUBCOMMITTEE ON INFORMATION SYSTEMS

of the Standing Committee on Administration

Executive Information System (EXIS)

JOHN McDOWELL
*Manager,
Information Systems
Arizona Department of Transportation*

The Oregon State Highway Division focuses on five keys to having a well run organization. Our vision is to have:

- 1) An annual planning process that focuses on performance (setting goals and objectives).
- 2) A linkage between planned performance and budget and staff
- 3) Managers that actively plan, and are accountable for actual accomplishments.
- 4) Ways to train, develop, and reward people.
- 5) A reporting structure that tracks results.

As part of implementing these keys, the Oregon State Highway Division now has an executive information system (EXIS). EXIS is becoming an integral part of our progress toward a well-run organization. It provides summarized customized information linking planning and budgeting by comparing actual with projected, and it is a tracking tool.

EXIS delivers information to our managers

quickly and efficiently and reduces the need for staff to deliver management information. We want managers to:

- 1) Make timely decisions of high quality.
- 2) Implement those decisions with the best use of available resources.

To accomplish that, managers need accurate, timely information that:

- 1) Is what they want, when they want it.
- 2) Is consistent throughout the organization.
- 3) Doesn't require searching through many reports for a single piece of information.
- 4) Helps them spot trends (EXIS uses color coding and graphics). Managers are sometimes interested in details, and they are available if needed.
- 5) Uses minimal staff time to create managerial information.

We know that managers base decisions on conversational data. They rarely decide based purely on data; they rely on opinions from their peers and subordinates. EXIS cannot replace this aspect of decision-making, but it does get everybody on the same information base.

Managers want to know how changes would affect the information they see.

We also know that managers will request additional detail or analysis. Now, managers ask fairly broad questions (i.e., are we over budget?). If there is anything unusual or unexpected in the answer, they usually request follow-up information, or analysis. Managers want to know how changes would affect the information they see. EXIS allows managers to get summary information, which allows them to focus requests to staff for more details or analysis.

Development

The development of EXIS began in July of 1988. Since the first version went on-line about a year later, both its capabilities and the number of users have increased. The system provides managers with a consistent, easy-to-use interface. EXIS summarizes information from multiple management systems including accounting, budgeting, personnel, payroll, and maintenance management.

Oregon chose to focus first on information that was important to all managers. EXIS provides organizational information to all top level management including:

- 1) Actual versus budget expenditures.
- 2) Filled versus budget positions and Affirmative Action percentages.
- 3) Use of work force, showing overtime, sick leave and vacation leave.

- 4) Planned versus actual expenditures for different maintenance activities.

- 5) And recently, performance indicators that rate results against benchmarks.

We know that managers base decisions on conversational data. They rarely decide based purely on data; they rely on opinions from their peers and subordinates.

Expenditures, positions, and work force use are fairly common. We are introducing performance indicators to measure how well the organization performs in four broad groups: Labor efficiency, Work quality, Material utilization, and Safety. Each group is broken down to indicators for specific work units. We combine individual indicators by weighting them according to their importance. Performance indicators will serve as the basis for gain-sharing. They will receive much attention, and boost the demand for EXIS.

EXIS requires an IBM-type PC attached to the Department's IBM mainframe. The Highway Division is a relatively small, flat organization. Managers at the highest organization level routinely look at information down a couple of steps in their organization. We went to a mainframe-based system because there was too much data to down load to PC's on a regular basis.

EXIS can slice the information by program within the organization, or the organization within the program at any level.

EXIS is mouse-driven; with a click of the mouse, the screen fills with a graphic display of information. It begins by showing a breakdown of the Division at the highest organizational level. A user then can "layer down" through the organization by clicking on the desired title.

EXIS can slice the information by program within the organization, or the organization within the program at any level. It represents about 20,000 pages of computer printout, all available with a few clicks of the mouse.

Displays are color coded (when appropriate) to give managers a quick look at what is good (green) or bad (red). Graphic images are available by clicking on numbers rather than titles.

Experiences

We could have improved our implementation in two areas. First, we used "beta test" (pre-commercial release) software. This slowed development because we spent much time keeping the system running. Second, we expect to need to do some rework because we chose to put the system on-line before we knew all informational needs. Overall, we feel that the benefits of bringing EXIS up quickly outweigh the disadvantage of beta test and quick design.

There are also two areas where we made the right moves. First (and most important) top management was the sponsor of the development. This was not a project started because the Information Systems folks thought it would be a good idea. It happened because the State Highway Engineer said "we have to have it", and then made the resources available to make it happen. EXIS would not have been possible without that level of commitment. Second, maintenance of all the information is the responsibility of the people who maintain the base systems. The EXIS staff is not responsible for keeping the data correct or accurate.

What's Next

EXIS will continue to expand. We will incorporate project status with financial information, bring legislative issues and bill status under the EXIS umbrella, and incorporate electronic messaging into EXIS. We also plan a help function that will tell managers what system the information is coming from.

By moving to an Executive Information System, we now have a tool for changing the culture of the organization.

Incorporating project status and financial information will be done much like other EIS's around the country. Managers will be able to slice the information in many different ways. We will again use color coding to help them identify quickly any problem areas.

Conclusions

By moving to an Executive Information System, we now have a tool for changing the culture of the organization. We are changing the way we deliver information to managers. We have given high level management direct and quick access to data. Managers can spend time thinking about the organization instead of waiting days for subordinates to appear with data. They can know immediately whether we are over or under budget and why—also whether we are getting results. Plus, the system makes it possible and reasonable to hold managers more accountable.

Moving quickly, especially when the technology is new, has risks. In this case, we believe the long-term payoff will show that we made an excellent investment.

ADMINISTRATIVE SUBCOMMITTEE ON INTERNAL AND EXTERNAL AUDIT

of the Standing Committee on Administration

Peer Review of Transportation Department Internal Audit Programs

FRANK G. MORWAY
*Chief Examiner,
Michigan Department of Transportation*

It is a pleasure to be here today to make this presentation on behalf of the Subcommittee on Internal and External Audit's Task Force on Peer Review. The peer review process is something that I have been involved in for the past three years as a member of the Subcommittee on Internal and External Audit, and in April of this past year, I assume the chairmanship of the Task Force.

I will be discussing:

- What is Peer Review?
- Why is it needed?
- What the AASHTO Subcommittee on Internal and External Audits has done to meet this need.
- What support is needed from you.

What Is Peer Review?

Peer Review is an external quality control review program. It is a review of an audit organization's operations by another organization not af-

filiated with the one being reviewed to determine that:

- 1) the audit organization's internal quality control system is in place and operating effectively and
- 2) established policies and procedures and applicable auditing standards are being followed in its audit work.

In the case of AASHTO member departments, the review would be performed by a team of auditors from various transportation audit organizations providing an independent review of a specific transportation department's audit organization to determine the quality and performance of that audit group's compliance with professional standards.

Why Is It Needed?

The simple answer would be that it's a requirement of Government Auditing Standards and

therefore it needs to be done. However the simple answer is not always the best answer, and I'm sure, not the answer that would satisfy the chief administrative officer of most transportation departments. To answer the question 'why is it needed?' one should know what has led to this requirement.

Recently there has been concern expressed over the quality of the work of public accounting firms. The latest one being the Savings and Loan failures. Most of what you hear or read in the news media centers around the ethics of certain individuals in Washington. But as this event continues to unfold there will be more questions raised as to where were the auditors, what did they do or not do, and what should they have done based on the professional standards.

The American Institute of Certified Public Accountants (AICPA) in a report entitled *Report of the Task Force on the Quality of Audits of Governmental Units*, dated March 1987, indicated that substantial evidence existed that audits of governmental units have not always been adequately and properly conducted in accordance with applicable standards. That report recommended that auditors and audit organizations performing audits of governmental funds should be required to participate in a peer review program that includes reviews of the government audits. As part of that recommendation the report went on to say:

"The requirement should be included as a qualifications standard in the forthcoming revision of the Comptroller General's Standard for Audit of Governmental Organizations, Programs, Activities and Functions. The requirement should be included in the proposed single rule pertaining to single audits of federal financial assistance."

At this point you may be asking what is the relationship between Certified Public Accountants (CPAs) and the internal auditors of the member departments of AASHTO. One connection is that many of the individuals that head the internal audit organizations of AASHTO member departments and their staff are either CPAs or Certified Internal

Auditors (CIAs) and are also bound by those professional standards just as many of you bound by the standards of your profession.

Standards help ensure that audits are fair, objective and reliable assessments. Federal legislation requires federal inspectors general comply with audit standards established by the Comptroller General for audits of federal organizations, programs, activities and functions commonly referred to as *Government Auditing Standards* or the yellow book.

The legislation further states that the inspectors general ensure that audit work conducted by non-federal auditors of federal organizations, programs, activities and functions comply with Government Auditing Standards. The fourth general standard of the Government Auditing Standards, which was last revised in 1988, requires audit organizations conducting government audits to have an appropriate internal quality control system in place and participate in an external quality control review program at least once every three (3) years by an organization non affiliated with the organization being reviewed and make the report on external quality control available to other auditors using their work and to appropriate oversight bodies.

The AICPA and the Institute of Internal Auditors (IIA) have issued similar requirements.

One last point that I would like to make in this area is that in 1987, while the yellow book was still in draft form, the AASHTO Subcommittee on Internal and External Audits formed the Peer Review Task Force to survey AASHTO's member departments to elicit opinions on the need for peer review. Over 40 states responded to each of the two surveys and 70 percent of the respondents agreed that AASHTO should develop peer review guidelines.

What Has the AASHTO Subcommittee on Internal and External Audits Done to Meet This Need?

The survey results were presented at the 1988 Subcommittee meeting. As a result of that survey the report recommended that a task force be formed

to develop peer review guidelines. The Subcommittee accepted the report and requested the existing task force to develop the guidelines.

I will not discuss all the details that went into developing the guidelines, but simply state that existing sources were used as our starting point. During a two month exposure period in 1989, comments were received from 27 states, the Commonwealth of Puerto Rico and the United States Department of Transportation, Office of Inspector General (USDOT O.I.G.). Fifteen of those respondents offered suggestions to improve the draft document. These guidelines as well as drafts of proposed bylaws, a staff qualifications questionnaire and evaluation methodology were presented at the 1989 Annual Subcommittee meeting along with other recommendations; one being that two pilot peer reviews be performed to test the proposed system.

The Illinois Department of Transportation and the Louisiana Department of Transportation and Developments audit organizations volunteered to serve as pilot projects. Two peer review teams were formed. The team that was to review Louisiana's audit organization was headed by Mr. Albert E. Burks, Manager of External Audits, for the Texas State Department of Highways and Public Transportation's Internal Audit and Review Section. The team to review the Illinois audit organization was headed by Mr. Timothy R. Maloney, Manager of the Bureau of Auditing, New Jersey Department of Transportation. Representatives from Arkansas, Arizona, Minnesota, Mississippi and Virginia Departments of Transportation also volunteered to serve on these review teams. No member from the task force served on either team in order to give us a completely unbiased test.

Also, at the time the teams were being put together, drafts of the proposed bylaws, staff qualifications questionnaire and the evaluation methodology presented at the 1989 annual meeting were submitted to the membership for comment. The comments received were incorporated into these documents for use in the pilots.

The Louisiana pilot was completed on schedule. The field work was performed in a week with three people. With preparation and write-up time, there were less than 400 hours invested in the review. Other than the issue of report format the pilot was considered a success. Success was defined as: were the guidelines clear, useable and could the field work be completed in less than two weeks and cover all the applicable audit standards. Based on this pilot the report format was revised to tie more closely to the evaluation methodology, which included criteria definitions for report opinions.

The Illinois pilot was cancelled due to budgeting constraints on out of state travel and the lack of acceptable alternatives based on the timetables established.

Based on the results of the one peer review pilot, the task force recommended that the Subcommittee adopt the Peer Review Bylaws and select the Peer Review Panel to oversee the program. This was adopted by voice vote at the meeting.

Subsequent to the enactment of the Peer Review System by the Subcommittee, a peer review has been completed in Illinois. Although a final report has not been issued, there were no problems encountered in conducting the review.

Throughout the process there was much discussion regarding alternatives. Discussion centered on hiring public accounting firms to conduct peer reviews and whether any reviews conducted by the various state Auditor's General or USDOT O.I.G.'s would meet the requirements. We all agreed that the AASHTO peer review would be an optional program. One that should be endorsed, but not required. Hiring public accounting firms to perform these reviews would probably be more costly than the AASHTO peer review system. We also agreed that reviews conducted by state Auditors General or USDOT O.I.G.s would meet the professional standards. However, both the O.I.G.s and the state Auditors General have some oversight responsibility for the state audit organizations' work and are not necessarily looking at our system as a peer. There are benefits of the AASHTO Peer Review System.

One is cost. The only cost to the state being reviewed is an equal commitment of time to serve on future review teams over the next three years. Each member department would pay its own travel and subsistence expenses. Secondly, and more importantly, is the individual cross training or educational benefits received from participating in the program. An auditor on a review team would be obtaining first hand knowledge about how other states' audit organizations operate. This is something they would be able to take back to their own organization to make it more efficient and effective as well as improve quality.

What Support is Needed From You?

Two things:

- That you fully support the Peer Review System as adopted by the Subcommittee on Internal and External Audits.
- And that you strongly encourage the audit organizations of your departments to participate in the AASHTO peer review system to improve quality and effectiveness.

ADMINISTRATIVE SUBCOMMITTEE ON LEGAL AFFAIRS

of the Standing Committee on Administration

Transportation Contract Monitoring Policies: Utilization of Computers

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Awareness of the National Issue— Potential of Bid-Rigging Today

The potential for anti-trust violations continues to be a National issue of concern for the United States transportation community at the National, State, and local government levels of responsibility. With the pending increase in Federal Highway Trust funds from \$12–13 billion to \$15–20 billion in the next 3–5 years, and with State government budgets increasing by \$100's of million dollars, the total expenditures for the construction and maintenance of transportation facilities will increase to above \$50–60 billion per year. In the past when the volume of funds increased, the potential for firms to violate anti-trust increased. A knowledge and awareness of this problem and solutions is needed to protect the "taxpayer's dollars" from these potential crimes.

Purpose: Need to Raise the Level of Awareness

One of the major purposes of this paper is to raise the level of awareness that "bid-rigging" is a very real potential current-day problem that threatens the integrity of the funding base of the National transportation system.

There is a need to foster Federal and State cooperation and exchange of information to help increase awareness of the need for contract monitoring and to create further initiatives to ensure that a competitive market exists in the construction of highway and transportation facilities.

The AASHTO/FHWA-sponsored meeting on Anti-Trust and Transportation Legal Affairs, held at Lake George, New York, November 15-17, 1989, initiated discussions of "state-of-the-art" capabilities

to monitor and analyze the activities, trends, bids and bidding behaviour of the construction industry to ensure the integrity of the contract letting process for both Federal and State funded construction projects. These capabilities increase public trust and confidence at both the Federal and State levels.

Is the Stage Set?

What is the potential for a reoccurrence of the 1980–1982 anti-trust investigations and indictments in the highway construction industry? Are the same conditions prevalent today as in 1980–1982?

Is the stage set today for collusion or bid-rigging as in the late 70's and early 80's?

When you look at the tremendous growth in highway construction budgets over the last several years, you see billion dollars per year programs in many states—for example, Florida, Illinois, Iowa, Massachusetts, New York, Pennsylvania, Texas, etc. These enormous amounts of money dictate the necessity of State and Federal agencies to take the

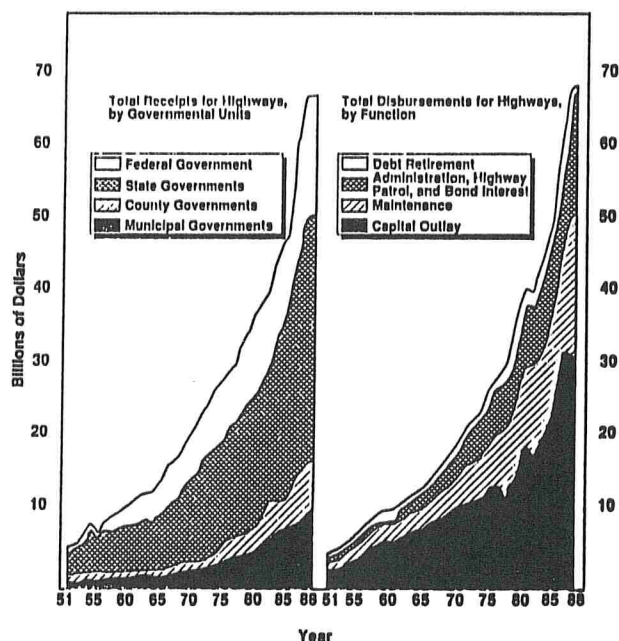
necessary steps to protect the "tax-payer's dollars." These large dollar programs certainly create an environment of potential windfall profiteering by the industry.

Federal Highway Revenues and Expenditures¹

To put the volume of revenues and expenditures into perspective, let us review the following statements and graphs.

Highways are financed using a variety of revenue sources, including direct user fees, license fees, tolls, and taxes on fuel and vehicles, and indirect fees, including income taxes and local property assessments. Figure 1 shows that an estimated \$69 billion in revenue was collected in 1988 for highways by all units of government. The sources of those funds were highway user charges (over 50 percent), bonds, general fund appropriations and tolls. Receipts were as follows: Federal, 22.4 percent; State, 49.7 percent; and Local, 27.9 percent.

Figure 1. Total Highway Receipts and Expenditures, 1951 to 1988*

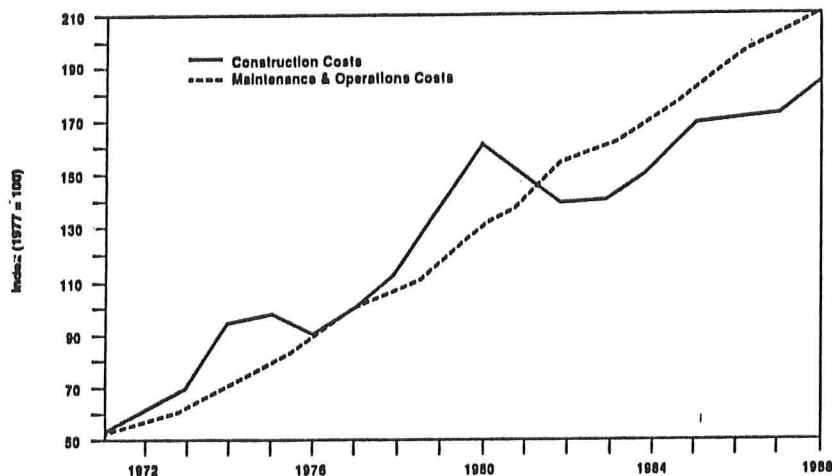


*Source: *National Transportation Strategic Planning Study*, U. S. Department of Transportation, March, 1990.

Expenditures totaling over \$68 billion are also shown in Figure 1. The distribution of these expenditures was as follows: capital improvements, 48.1 percent; maintenance, 27.7 percent; and all others, 24.2 percent.

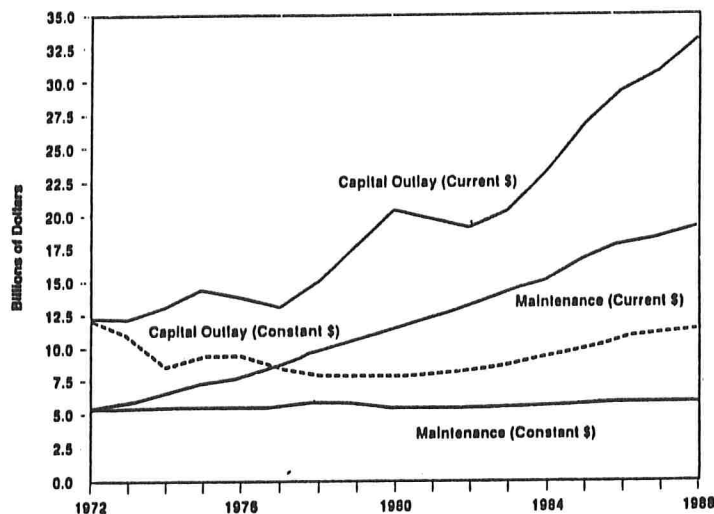
In Figures 2 and 3, highway cost trends from 1971 to 1988 and highway expenditures by all government units from 1972 to 1988 are given, respectively.

Figure 2 . Highway Cost Trends, 1971 to 1988*



*Source: *National Transportation Strategic Planning Study*, U. S. Department of Transportation, March, 1990.

Figure 3. Highway Expenditures by All Units of Government, 1972 to 1988*

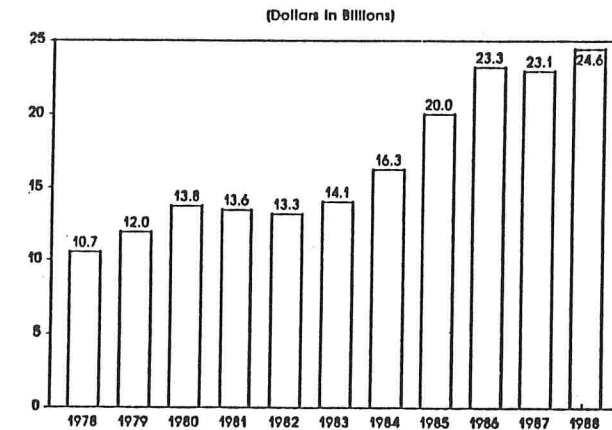


*Source: *National Transportation Strategic Planning Study*, U. S. Department of Transportation, March, 1990.

Total National Funding: Highways and Bridges²

Total highway and bridge construction across the United States has a total \$24.6 billion dollars for 1988. A review of the graph shows a tremendous increase in spending since 1984.

Figure 4. Spending on Highway Construction



Source: U.S. Dept. of Commerce

Table 1 lists some of the Nation's Largest Highway Projects which is indicative of record levels of spending for highway construction in the United States.

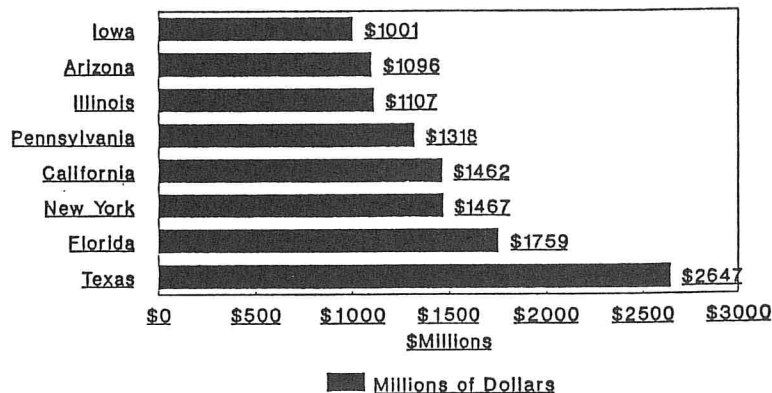
Table 1. Nation's Largest Highway Projects

| THE NATION'S LARGEST HIGHWAY PROJECTS | | |
|---------------------------------------|---|---------------|
| Location | Project | Total Cost |
| Washington | I-90 road, tunnel and bridges, Seattle | \$1.3 billion |
| California | I-105, Century Freeway, Los Angeles | \$1.1 billion |
| Florida | I-595, Fort Lauderdale | \$1.0 billion |
| Louisiana | I-49 from I-10 to I-20 (210 mi.) | \$1.0 billion |
| Texas | Hardy and West Belt toll roads, Houston | \$900 million |
| Pennsylvania | I-476, Delaware County | \$451 million |
| Florida | Eastern Beltway toll road, Orlando | \$433 million |
| North Carolina | I-40, Raleigh to Wilmington | \$417 million |
| Virginia | I-664, Hampton Roads crossing | \$370 million |
| Illinois | DePage County toll road, near Chicago | \$300 million |
| Minnesota | I-394, Minneapolis | \$300 million |
| Alabama | I-565, Huntsville | \$300 million |
| Michigan | I-696, Detroit | \$290 million |
| Massachusetts | Central Artery rebuilding, Boston | \$280 million |
| Pennsylvania | I-78, Allentown | \$277 million |
| Pennsylvania | I-676, Philadelphia | \$243 million |
| Arizona | I-10, Papago Freeway | \$241 million |
| Illinois | Dan Ryan 4-way rebuilding, Chicago | \$235 million |
| Nebraska | Interstate reconstruction, Omaha | \$230 million |
| Colorado | I-70, Glenwood Canyon | \$228 million |
| Kentucky | Waterson 4-way rebuilding, Louisville | \$160 million |
| Connecticut | I-91, Hartford to Massachusetts line | \$128 million |
| Texas | Dallas North toll road | \$124 million |
| Georgia | I-75, I-85, I-20 Interchange, Atlanta | \$115 million |

Sources: Federal Highway Administration; International Bridge, Tunnel and Turnpike Assn.

A review of Figure 5 shows that Iowa, Arizona, Illinois, Pennsylvania, California, New York, Florida, and Texas are members of the "Billion Dollar" Club. Texas at \$2.647 billion is by far the National Leader in highway construction dollars.

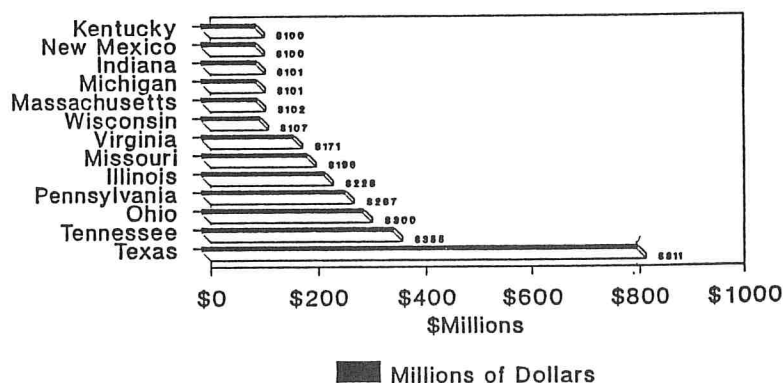
Figure 5. Billion Dollar Club—Highway Construction Dollars



Highway & Heavy Construction, JUNE 1988

A review of Figure 6 shows that Kentucky, New Mexico, Indiana, Michigan, Massachusetts, Wisconsin, Virginia, Missouri, Illinois, Pennsylvania, Ohio, Tennessee, and Texas are members of the \$100 Million Dollar Resurfacing Club. Texas again leads the Nation in resurfacing dollars.

Figure 6. \$100 Million Club—Resurfacing



Highway & Heavy Construction, JUNE 1988

Yes, the Stage Is Set

These large volumes of expenditures for highways as shown above certainly set the stage for potential bid-rigging.

From the testimonies of the 1980–1982 investigations, it is a well-known observation that large volumes of money create the environment that is fertile and conducive to bid-rigging. Therefore, the stage is set for a high probability of a bid-rigging conspiracy today in some states.

However, the same conditions prevalent in 1980–1982 will not be found today. The bid-riggers certainly would employ much more sophisticated means today. Also, the government agencies that do not invest in staff, computer technology, and consulting contracts taking advantage of the available expertise will have an extremely hard time explaining their position in the event of a bid-rigging conspiracy in their area of responsibility.

Why Do Firms Rig Bids?

Bid rigging is good business for the profiteers, the construction companies. They know that the states and local governments are committing very limited resources and in some cases no resources to contract monitoring and collusion detection. There is virtually no uncertainty in a rigged market. The risk factor is judged to be very low. So, with very little chance of being caught, they are willing to take the risk because the profits are big. Even if they get caught, they still make a lot of money. Short of confession, the government agency stands a very poor chance of recovery. The companies and individuals will only confess to what they know you know. Within this scenario, why not rig the bids? Would you be willing to go to jail for six months or one year for a million dollars?

Effect of Anti-Trust Violations³ On the Foundation of the United States' Economy: Free Competition

Competition can be described as the foundation upon which America has built the world's most

productive economy. Over the past few years, the movement toward open competition has been a fundamental goal in Government Agency procurement initiatives. Substantial progress has been made in satisfying this goal. However, competition can sometimes spawn a vulnerability to collusion among competitors. In the general economy, price fixing, bid-rigging, and other typical antitrust violations have a devastating effect on the American public since such illegal activity contributes to inflation, destroys public confidence in the country's economy, and erodes our system of free enterprise. In the case of Federal and Local Government procurement, such crimes have the additional effect of increasing the costs of Government and detracting from the public's confidence in its Government. In particular, anticompetitive activity such as bid-rigging and price fixing undermines the Government's lawful ability to procure goods and services in an efficient, effective, and economical manner.

The Federal antitrust laws were enacted to preserve our system of free and open competition. They serve as our primary defense against unlawful attempts to limit competition and increase the purchase price of products and services. The Government must have an effective enforcement program to protect itself from anticompetitive activity. We must evolve a professional partnership among all Federal, State, and Local Government Departments of Justice Anti-Trust Divisions. These organizations play a primary and fundamental role in establishing contract monitoring procedures to help protect the foundation of free enterprise government.

Anti-Trust Law

Anti-trust has its American roots in the Sherman Act of 1890. That Act prohibits contracts, combinations and conspiracies that restrain trade; and attempts and conspiracies to monopolize. The Sherman Act was reinforced by the Clayton Act in 1914, which prohibits certain potential restraints on competition by tie-ins, exclusive dealing, interlocking directors, and mergers; by the Federal Trade Commission Act, also passed in 1914, which prohibits unfair methods of competition; by the Robinson-Patman Act, passed in 1936, which pro-

hibits certain price discrimination, and by the Celler-Kefauver Amendment to the Clayton Act, enacted in 1950, which put more teeth into the merger law.

Violations of the Law

Bid-rigging or price fixing schemes are violations of the Sherman Act. The common thread is a conspiracy of agreement or informal arrangement among independent competitors to limit competition by design for their excessive profit. Some of these schemes are: bid rotation, bid suppression, complimentary bidding, market allocation, and price fixing.

Department of Justice: Anti-Trust, 1981-1990⁴

From December 14, 1979 through October 17, 1990, the Antitrust Division initiated 345 criminal prosecutions involving 343 corporate defendants and 323 individual defendants in connection with conspiracies to rig bids on public highway and airport construction projects in 25 states. Felony prosecutions in Tennessee, Virginia, North Carolina, South Carolina, Georgia, Mississippi, Kansas, Texas, Nebraska, Florida, Kentucky, Maryland, Oklahoma, Iowa, Pennsylvania, Colorado, Vermont, South Dakota, Arkansas, Delaware, New Jersey, Connecticut, North Dakota, New York and Louisiana have charged violations of Section 1 of the Sherman Act, mail fraud, false declarations made before grand juries, false statements submitted to government agencies, obstruction of justice and aiding and abetting.

Usually, state highway construction contracts are let for competitive bidding several times per year.

Most state laws provide that a construction contract is to be awarded to the lowest bidder, following the opening of sealed bids. In these cases, the contractors agreed upon the low bidder prior to the contract letting. The prearranged low bidder would usually get the job as other contractors submitted intentionally high bids, knowing their turn as low bidder was coming. Sometimes payments were made in return for the high bid. In this way, the contractors avoided competition and significantly raised the price of the construction projects, most of which were federally funded in accordance with the Federal-Aid Highway Act.

The system used to rig bids in Tennessee is similar to that found in other states. Tennessee contractors generally gathered at a hotel in Nashville, the state capital, the night before the deadline for submitting bids on state highway work. During an evening of social gatherings, they would divide the projects and agree who would submit the lowest bids.

Two hundred sixty-five cases, involving 237 corporations and 220 individuals, have been resolved through guilty pleas. Two cases, involving 2 corporations and 3 individuals, await trial. In the 66 cases which have gone to trial, 34 corporations and 36 individuals have been convicted and 37 corporations and 44 individuals have been acquitted. The courts have accepted, over the government's objection, *nolo contendere* pleas from 21 corporations and 14 individuals.

Fines totaling approximately \$66 million and aggregate jail sentences in excess of 61 years actual incarceration have been imposed in these cases to date. The Antitrust Division is continuing these investigations with 7 grand juries impaneled.

Table 2. U. S. Department of Justice Anti-Trust Federal Cases (1981-1990)*

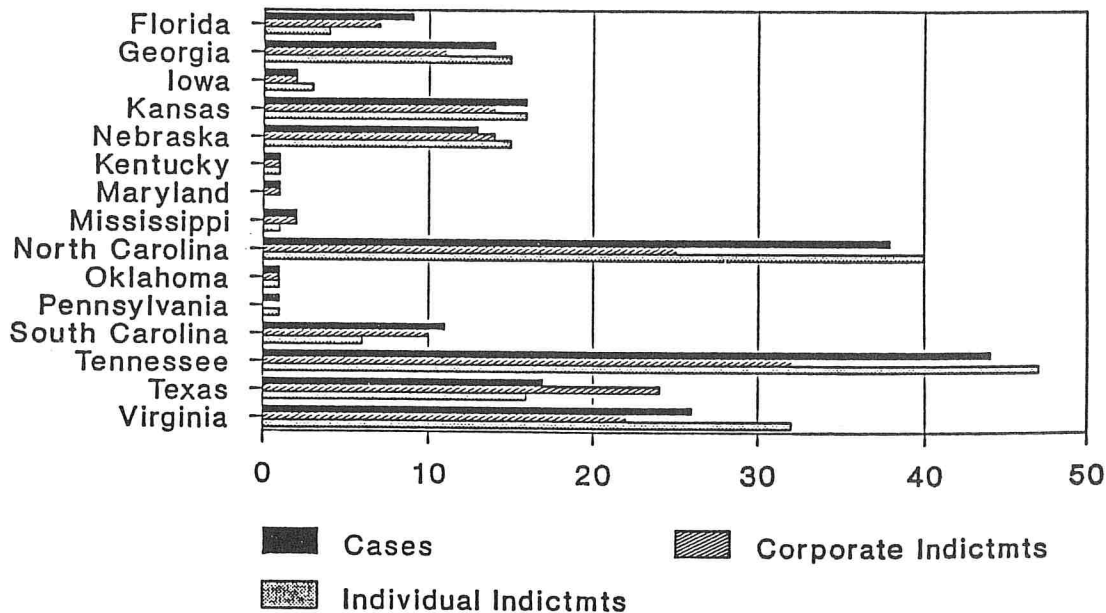
| Fiscal Year | Criminal Cases | Corps | Indivs | Convictions | | Total Fines (\$000) | | Jail Days | Total Civil Damages Recovered (\$000) |
|-------------|----------------|-------|--------|-------------|--------|---------------------|--------|-----------|---------------------------------------|
| | | | | Corps | Indivs | Corps | Indivs | | |
| 1981 | 70 | 74 | 83 | 77 | 59 | 16,178 | 660 | 7,041 | 2,830 |
| 1982 | 94 | 113 | 103 | 105 | 72 | 35,223 | 1,585 | 5,940 | 4,068 |
| 1983 | 98 | 122 | 113 | 88 | 83 | 19,430 | 1,463 | 6,543 | 249 |
| 1984 | 100 | 131 | 104 | 92 | 63 | 19,218 | 1,176 | 3,181 | — |
| 1985 | 47 | 50 | 36 | 83 | 53 | 8,633 | 846 | 1,356 | 258 |
| 1986 | 53 | 69 | 60 | 56 | 50 | 9,570 | 1,152 | 2,725 | 1,018 |
| 1987 | 92 | 119 | 116 | 66 | 48 | 16,265 | 1,636 | 1,994 | 1,590 |
| 1988 | 87 | 89 | 78 | 83 | 73 | 28,830 | 1,996 | 5,892 | 6,279 |
| 1989 | 86 | 88 | 76 | 86 | 76 | 25,600 | 2,892 | 7,473 | 3,090 |
| 1990 | 75 | 88 | 72 | 74 | 42 | 22,658 | 917 | 2,739 | 5,670 |
| Totals | 802 | 943 | 841 | 810 | 619 | 201,605 | 14,323 | 44,884 | 25,052 |

* Source: U. S. Department of Justice. Statistics Include: Electrical, Defense, and Highway Cases

Historical Extent of Bid-Rigging, National (1979–1983)⁵

Figure 7 shows by state, the number of criminal cases, corporations indicted, and individuals indicted for conspiring to rig bids on public highway and airport construction projects between December 14, 1979 and January 22, 1983.

Figure 7. Bid Rigging Cases—National 1979–1983**



**U. S. Department of Transportation—*Inspector General's Annual Report to Congress*

The Pervasiveness of Bid-Rigging Today⁶

A very clear indication that bid-rigging in the highway construction industry is still a “top priority” is obtained by reviewing the following excerpt from the 1990 Congressional Hearings which reveals the intensity of anti-trust from investigations at the present time.

Significant Investigative Accomplishments

The detection and prevention of bid-rigging ac-

tivities in DOT-funded construction projects continues to be one of our highest priority investigative projects. For FY 1988, our joint investigations with the DOJ Anti-Trust Division have resulted in 7 indictments, 16 convictions, \$600,500 in fines, and 20 years of probation. We are also emphasizing both proactive efforts in the areas of grants and direct contracts let by the Department.

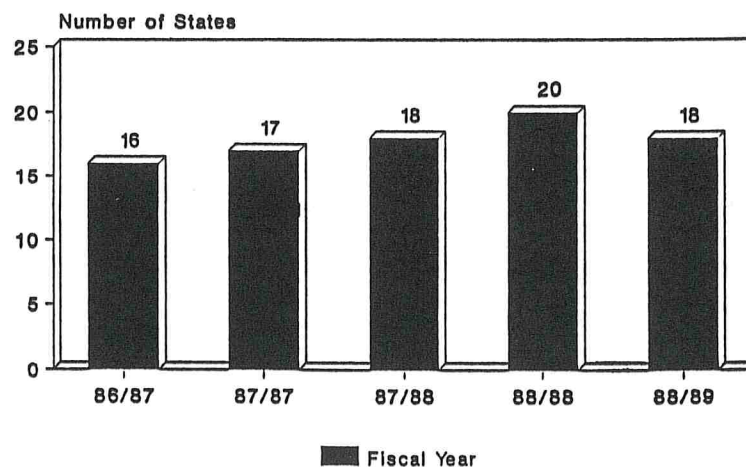
Table 3 presents the projected FY 1989 and FY 1990 investigative efforts by activity:

Table 3. USDOT Investigative Effort, 1989–1990

| Reactive Cases Number Closed) | FY 1989 | FY 1990 |
|----------------------------------|---------|---------|
| Employee | 45 | 45 |
| Grants | 95 | 95 |
| Contracts | 25 | 25 |
| Other | 30 | 30 |
| Totals | 195 | 195 |
| Total Targets | 235 | 235 |
| Proactive Projects (Closed) | 26 | 27 |
| Hotline (Number of Complaints) | 400 | 400 |

Figure 8 shows the number of States in which anti-trust investigations have been made, 1986–1989.

Figure 8. Number of State Investigations (Semi-Annual)*



*U. S. Department of Transportation—*Inspector General's Annual Report to Congress*

Bid-Rigging Profile⁷

Over the past several years, the following profile criteria have been developed to aid in the identification of those industries where conditions are present which are favorable to collusive bidding:

- a. Five or fewer bidders: Collusion is more likely to occur if there are few bidders or sellers. The fewer the bidders or sellers, the easier it is for them to get together and agree on bids or prices. Collusion may also occur when the number of firms is fairly large, but there are a small group of major suppliers and the rest are "fringe" suppliers who control only a small fraction of the market.
- b. Standardized product/service: The more standardized a product/service is, the easier it is for competing firms to reach an agreement on a common price structure. It is harder to agree on such forms of competition as quality or service.
- c. Predictable and/or repetitive contracting actions: Unpredictable or one-time-only contracts do not lend themselves to bid-rigging schemes such as bid rotation and market division. Predictable and/or repetitive contracting actions offer collusive bidders the opportunity to realize their designation as the winning bidder in a timely fashion; however, it also offers the investigator/analyst an opportunity to more definitively identify specific bid rotation and market division schemes.
- d. Annual dollar threshold: Depending on the volume of contracting activity at a specific government procurement center, a minimum annual dollar threshold for individual commodities or services should be incorporated in the profile criteria to focus initial efforts on larger dollar volume activities.

Bid-Rigging and Price Fixing Indicators⁸

A word of caution: "Indicators are indications, not evidence." Do not stop with the indications, they are the starting points. The list of indicators below is intended to facilitate recognition of those situations that may involve collusive bidding or price fixing. In and of themselves, these indicators will not prove that illegal anticompetitive activity is occurring. They are, however, sufficient to warrant further investigation. Use of indicators such as these to identify possible anticompetitive activity is important because schemes to restrict competition are by their very nature secret and their exact nature is not readily visible.

1. Bidders who are qualified and capable of performing but who fail to bid, with no apparent reason. A situation where fewer competitors than normal submit bids typifies this situation. (This could indicate a deliberate scheme to withhold bids.)
2. Certain contractors always bid against each other or conversely certain contractors do not bid against one another.
3. The successful bidder repeatedly subcontracts work to companies that submitted higher bids or to companies that picked up bid packages and could have bid as prime contractors but did not.
4. Different groups of contractors appear to specialize in Federal, state, or local jobs exclusively. (This might indicate a market division by class of customer.)
5. There is an apparent pattern of low bids regularly recurring, such as corporation "x" always being the low bidder in a certain geographical area or in a fixed rotation with other bidders.
6. Failure of original bidders to rebid, or an identical ranking of the same bidders upon rebidding, when original bids were rejected as being too far over the Government estimate.

7. A certain company appears to be bidding substantially higher on some bids than on other bids with no logical cost difference to account for the increase, i.e., a local company is bidding higher prices for an item to be delivered locally than for delivery to points farther away.
8. Bidders that ship their product a short distance bid more than those who must incur greater expense by shipping their product long distances.
9. Identical bid amounts on a contract line item by two or more contractors. Some instances of identical line item bids are explainable, as suppliers often quote the same prices to several bidders; however, a large number of identical bids on any service-related item should be viewed critically.
10. Bidders frequently change prices at about the same time and to the same extent.
11. Joint venture bids where either contractor could have bid individually as a prime. (Both had technical capability and production capacity.)
12. Any incidents suggesting direct collusion among competitors, such as the appearance of identical calculation or spelling errors in two or more competitive bids, or the submission by one firm of bids for other firms.
13. Competitors regularly socialize or appear to hold meetings, or otherwise get together in the vicinity of procurement offices shortly before bid filing deadlines.
14. Assertions by employees, former employees, or competitors that an agreement to fix bids and prices or otherwise restrain trade exists.
15. Bid prices appear to drop whenever a new or infrequent bidder submits a bid.
16. Competitors exchange any form of price information among themselves. This may result from the existence of an "industry price list" or "price agreement" to which contractors refer in formulating their bids, or it may take other subtler forms such as discussions of the "right price."
17. Any reference by bidders to "association price schedules," "industry price schedules," "industry suggested prices," "industry-wide prices," or "market-wide prices."
18. A bidder's justification for a bid price or terms offered because they follow the industry or industry leader's pricing or terms, this may include a reference to following a named competitor's pricing or terms.
19. Any statements by a representative of a contractor that his company "does not sell in a particular area" or that "only a particular firm sells in that area."
20. Statements by a bidder that it is not their turn to receive a job or conversely that it is another bidder's turn.

Comments on Contract Monitoring Organizational Policy⁹

One of the biggest problems with many top government officials is the "Ostrich Syndrome" that is a denial that Anti-Trust or Bid-Rigging is a real threat and problem today. There is a lack of recognition that Anti-Trust is a continuous problem. This is precipitating the lack of action by State agencies, both the Department of Transportation and the Department of Justice. There is no commitment of resources to monitor and review their own State markets. There is a need for a State Office of Contract Monitoring that would be responsible for all State purchase contracts covering all State agencies, i.e., agriculture, administration, transportation, etc. Only a few State's DOTs have established contract monitoring functions; in particular, Virginia, Florida, and North Carolina. There are no positions for full-time analyst and no funds or resources being made

available for their support. There is no budget provided for development of automated analytical techniques or contracts with consultants to bolster small or non-existing staffs.

Some of the steps necessary to effect a solution to these problems are:

- The contract analysis and monitoring office needs to be directly tied to a position of power, the Department of Justice—Anti-Trust Office.
- The contract monitoring office can not be buried in a highway agency at a level that negates productivity in detection and responsible, timely follow-through.
- The denial at high levels that bid-rigging is a continuous local, regional, and national problem creates this lack of support. This must be corrected to effect the above.
- Dedicated resources of staff, equipment and funds must be committed by top management.
- Many states have automated data bases and computerized monitoring systems installed; however, they don't know how to use the system. Therefore, there is a need for systematized training in how to establish standard contract monitoring procedures and policies. Currently, in most states, there is no knowledge base. They don't know what to look for or what to do.
- There is a need to establish an interdisciplinary staff with major skills of construction management and engineering statistics, economics, and data processing. The major requirement is a complete knowledge base of construction, i.e., all facets: right-of-way, planning, design, contracting, construction (field sites), and maintenance.

- There are also legal problems to overcome. There are very few states that have laws to protect evidence of information resulting from analysis and monitoring of contracts from the Freedom of Information Act. The release of analysis results to the public or to the industry negates the monitoring process.
- There is a need to budget and commit funds to use consulting firms to analyze existing data and provide an "unbiased third party" view of contracts which would bolster understaffed offices; and, perhaps, in some cases might be easier to fund.

Contract Monitoring: Utilization of Computers

Computers can and have been very effectively used to analyze contractor bidding patterns in several states; for example, Pennsylvania, Florida, Virginia, North Carolina, et al. Computer analysis has been used in some of the highway bid-rigging investigations. The analysis identified contracts that had high indications of suspicious activity. The contractors involved were selected for additional investigation. Computer systems are designed to process data gathered by a bidding system, organize the data into a historical data base, generate user defined reports, and allow the data base to be queried to answer specific questions.

Several states have built historical data bases, which contains large amount of information collected from all phases of the contracting cycle. Descriptive project and estimate information is gathered from the pre-letting phase; bid and contract award information is gathered from the letting and award phase; and subcontractor and contract completion information is gathered from the construction phase. The result is a data base specifically designed to support executive level decision making with timely management reports and ad hoc analysis capabilities.

Also, these data bases are directed at supporting the need of a contract monitoring function in the highway and transportation agency. However, most

of the states' systems provide only very elementary descriptive statistics relative to analyzing and monitoring bidding activity, bidding and market share, item price analysis, cost and quantity analysis and contractor analysis.

There is a strong current need for the funding and support to develop more advanced statistical analytical techniques which will emphasize and incorporate the bid-rigging and price fixing indicators presented above. There is a need for automatic programs to be developed to determine complementary bidding, bid rotation, like bids, prime and subcontractor reciprocate bidding, etc.

These computer programs should provide factual evidence to indicate whether an anti-trust violation exists. The information results should substantiate bid-rigging and/or price fixing; and, should definitely be available to support collaboration or help substantiate given sworn testimony in "hot" cases.

Feasibility of PC Based Contract Monitoring

While it is true that automated techniques for collusion detection that have been developed since 1982 have been a great step forward in the "state-of-the-art," they are still for the most part comprised of descriptive statistical and minor analytical techniques. These systems have not been advanced much for the past three years. No technological advances or increases in sophistication have been developed for collusion detection over the past several years.

The feasibility exists now due primarily to tremendously expanded data storage on hard drives of up to 600 MB at very economic costs. Also, the availability exists for 160 MB Quick Access to 8 MB RAM at economic costs per workstation. Removable cartridges (disks) provide expandability and backups for both data base and programs.

Advantages

- **Security**—storage can be physically secured and back-ups locked up.

- **Integration of analytical tools**—many software packages (e.g., statistical packages, geographic analysis, data base systems, operations research, word processing, spreadsheets, etc.), are readily available and data/results can be shared among all these packages.
- **Mainframe independence** with lower costs/overhead and more timely access.
- **Ease of analysis** by non-programmers and programmers, which promotes ad hoc data analysis.
- **Expandability**—as new tools are developed/purchased they may be more easily linked to existing data and analytical structure.
- **Portability**—portions of data may be collected/worked upon off-site (office); for example, at the job site or in travel.

Disadvantages

- **Lack of technical support**—Large existing companies still support mainframe systems.
- Must still maintain link to mainframe for data acquisition.

PC Based Layout

Hardware would consist of a large 600 MB file server linked to workstations (micros) and mainframe and laser writer/color ink-jet printers.

Software would consist of: statistical package, data base package, graphics (can be linked to spreadsheet and statistical package), geographic query package, word processor, spreadsheet, programming languages: SAS, Fortran, BASIC, C, Pascal, etc.; and, "canned" detection packages reading data from a given spreadsheet format, outputting reports and data as text files.

Need for Funding

There is a definite need for commitment by Federal, State, and Local Area Governments, the U. S. Department of Justice, and State Departments of Justice and Administration to sponsor research funds to support:

- The development of Advanced Statistical Techniques for contract monitoring.
- The development of a PC-Workstation for contract monitoring, taking advantage of the available fast evolving technology of PC hardware and software.
- Enhancements to the existing mainframe computer software systems.

Primary Responsibility and Purpose for Contract Monitoring in Federal, State, and Local Government Agency Procurements

Government Agencies with the assistance of the Anti-Trust Section of the Attorney General's Office have a primary ethical and legal responsibility and should perform periodic reviews and analysis of all agency contract bids for the purpose of detecting bidding irregularities. This responsibility is based upon the public trust of government officials to wisely and economically use the public tax-dollar for producing Federal, State, and Local Government services without fraud, corruption, and collusive contract practices.

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ADMINISTRATIVE SUBCOMMITTEE ON LEGAL AFFAIRS

of the Standing Committee on Administration

A New Way to Undertake Public Works Projects Through Innovative Contracting Practices

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When we hear the word “innovative” we think of the word “invention”—something new that has never been done before or the application of a new idea that produces something totally different. What I want to talk about is the application of some new, but many *old concepts and principles* to produce innovation in our public works contracting practices. These concepts and principles are based on the work that the Transportation Research Board (TRB) Task Force on Innovative Contracting Practices is undertaking.

In connection with consideration of innovation I have to ask, what will it take to snap government and the construction industry from the legacy of “well we have been doing it this way for 100 years and it works, why change it”? The answer should be obvious. Doing it the old way, even when you produce good results, stymies finding a better way of doing it more effectively in the long term.

It should be a goal of innovation in connection with the competitive bid contract process for public works to produce less costly, higher quality products that are also oriented toward life-cycle costs

and other public interest factors. This means that the contracting system must be more efficient and effective while also trying to deliver a better product. Within the process, and within the traditional concepts of “lowest responsible bidder,” I submit that certain modifications to the bidding process can be advanced with a fairly high degree of probability that they will improve the public works contracting process.

The Low Bid Concept

About 150 years ago, our forefathers bestowed the competitive bid concept on us in order to curb corruption, inefficiency and mismanagement by government officials. Over the years through social and economic pressures, the additional qualification of lowest “responsible” bidder and a “public interest” determination were added to statutes which control the authority to let and award public works contracts.

What is the rationale for the lowest bidder concept? The statutory requirement is often stated to protect the taxpayer from extravagance, corruption

and other improper practices by public officials in connection with public works contracts, with the side effect of protecting the public official from the demands of those who seek political favors by obtaining such contracts. The bidding requirement is also intended to provide the taxpayers with the benefits of America's free enterprise system by delivering adequate, safe and efficient transportation facilities at the lowest price that responsible, competitive bidders can offer.

The principles of competitive bidding generally require: preparation of plan specifications for the work; public advertisement to bidders inviting submission of proposals; formal submission of proposals to the contracting agency; submission of financial security by the low bidder guaranteeing his acceptance of the award; and consideration of proposals under uniform criteria and award to successful bidders.

There are numerous incidents where the competitive bidding process has not worked as smoothly as theory would predict. In the past, major problems have arisen in connection with competitive bidding, most notably in the collusive bidding area. Stringent precautionary measures implemented by public works agencies did not prevent bid-rigging during the late 1970s and early 1980s and are less likely to work in the future as bidders become more and more sophisticated. Care may also have to be exercised in regard to the stability of the competitive bid contracting community when there is a limited supply of available contractors in a particular area or where competitive bidding does not produce good results.

As the size of projects increase, such as billion dollar projects, it is becoming more and more obvious that there are few companies that can competitively bid work of this scale. Thus, the possibility exists for a monopoly, a one-bidder concept. Anti-collusion statutes exist that may prevent effective joint venturing of several smaller companies to compete with the giants for these projects.

The competitive bid process has worked quite well for many, many years. Therefore, the competitive bid process should be retained within innova-

tive contracting practices and it will be found that it is needed. The process should be adjusted so as to allow government officials to be the best administrators possible, allow innovation in getting the best quality performance for the dollar spent, and which, in the long term, buys the best combination of volume and quality in public works projects for the taxpayer. No matter how good the proposed systems look on paper, the abilities, the honesty and integrity of public officials, and the desire to make the system work by those that administer it, will be key factors in determining whether proposed modifications work or fail.

The Specifications

The first thing we have to recognize is that we are no longer constructing our projects in open areas on new alignments, as was prevalent in the 50s, 60s and 70s. We are now undertaking extensive rehabilitation of our existing facilities; very little of our construction is on new alignment. Our transportation agencies must seriously look at their specifications and make modifications, so that they reflect the type of work that we are actually performing.

To get to the very basics of what is involved in public works specifications and the letting processes, it is found that essentially the specifications and letting processes are the public agency's determination of risk assignment. At the one end of the scale you have the risk of all unknowns which the public agencies place on the contractor. At the other end, through adjustments in the cost of the contract performance which the public bears, the risk of the unknown is placed on the public agency.

It is clear that in innovative contracting there may be considerable modifications of risk assignments and therefore the roles played by both the public and private sectors in the process. These roles may undergo substantial change from that traditionally played in the competitive bidding process. Government will be more goal-oriented with respect to their specifications and industry will have greater control over the components, equipment and labor. There will be strong resistance to chang-

ing these roles; to the shifting of responsibility; as well as, what are appropriate controls which should be exercised by government to assure the public that they are getting what they pay for?

In innovative contracting practices, a risk assignment balance has to be found between the wide perimeters. This balance must be both "fair" and "equitable". The process must be understood by those who work within the process, both government side and contracting community. Therefore, in innovative contracting practices, who ends up bearing the risk of how it is distributed between the public agency and the contractor within the contract processes and within the bidding process itself must be a major consideration.

The use of Standardized Specifications throughout the country may not only facilitate interpretation of the specifications but should facilitate actual construction and reduce on-the-job conflicts, thereby reducing construction costs.

The last element of spec writing is that the goals of innovation must be clearly communicated from the design (spec writing phase) in the construction phase so there is a thorough understanding of the requirements. On projects where innovation is attempted, there should be a review that ensures that "constructability" is built into the specification process. A pre-bid and pre-design conference whereby goals of innovation and desired results are discussed with industry representatives (potential bidders) prior to finalizing design specifications might help the technical specification writer to ensure that constructability is considered in the specifications. It would also help to ensure that innovation is encouraged by contract terminology and not precluded by prescription requirements normally found in many specifications. This communication of conceptual desires would also be a good place to bring to contract administrators (project engineer, etc.) into the thinking climate for innovation in the construction processes. The most innovative of design specifications could be negated if the project engineer in the field is not approaching the contract in an atmosphere of reception to innovation.

Good communication also hits another aspect. Many times, the state of the art relative to new equipment is not understood by the designers. Therefore, there is a production capability that is lost by utilizing specifications that revolve around old equipment. Innovation should include review of the specification writer's understanding of new equipment capabilities. Of course, it should also be extended to knowledge of new materials.

Time is Money Concept

TRB Task Force discussed the "Time is Money" concept. In Great Britain this concept is being used extensively. The proper selection of projects that do not have a lot of unknowns, lend themselves to the "Time is Money" concept. The cost of a project involves more than the pure cost of units being placed by the contractor, it also involves inconvenience to the public. This inconvenience can be measured in dollars and that measure, in dollars per day, can be introduced in the bidding process by having the contractor bid the completion date by indicating how much time it will take to produce the project. The contracting agency's role would be to set an overall time maximum perimeter, but the contractors themselves would compete on not only the cost of the units, but the time factor as well. For example, if \$25,000 a day figure is used and Contractor A bids that it will place the units for \$1,000,000 and take 120 days to perform the work, and Contractor B bids that it will cost \$1,100,000 for the units and can do the work in 90 days, these two bids would be analyzed in the following way: Take Contractor A's unit bid prices of \$1,000,000, plus 120 days x \$25,000 or \$3,000,000 and Contractor B's unit price bid of \$1,100,000, plus 90 days x \$25,000 or \$2,250,000 and it is found that Contractor A's total price, both relative to the units and public convenience, would be a total of \$4,000,000 and contractor B's total price would be \$3,350,000. Contractor B, would, therefore, be the lowest responsible bidder when you consider both factors, by some \$650,000.

This "Time is Money" aspect of the bidding process has been used successfully in some parts of this country. If it is more widely employed, particu-

lar attention must be paid to the determination of the public cost factor so that it is realistic because the public cost factor is also utilized in connection with incentive/disincentive clauses. The incentive/disincentive would work in the following way:

Contractor B performs the project, but he builds it in 70 days. Under an incentive/disincentive, measured by the contractor's proposed completion date would mean that he would receive 20 days x \$25,000 or an incentive of \$500,000. If instead, Contractor B takes 102 days, he would receive a disincentive on the project of \$300,000 (12 days x \$25,000).

In connection with the "Time is Money" concept, adding a factor of "quality" in determining the lowest responsible bidder could be considered. There are severe reservations expressed by most members of the TRB Task Force relative to trying to implement a quality component within the "Time is Money" concept. This primarily centered around the fact that there are no standardized specifications from jurisdiction to jurisdiction and there are no regional or national testing centers for materials. These factors could, therefore, cause the "quality" component to be very subjective.

The Use of Warranties and Guarantees

The TRB Task Force discussed the use of warranties and guarantees in public works contracts. To implement warranties or guarantees in Federal-aid public works projects, the Federal Government has to relax or overrule its long-standing policy that guarantees or warranties are of a maintenance nature and, therefore, cannot be funded in connection with capital improvements. There has been some indication that there will be some relaxation of this long-standing policy and it appears that there is a willingness to better understand and appreciate that capital improvements incorporating guarantees and warranties having the capability of producing a better life-cycle product is not a shifting of maintenance responsibilities and costs from the State or local level to the Federal government.

The TRB Task Force considered the Northern European method of contractors and how they are

selected to perform the work. They get involved from day one and select the equipment, materials and workmanship that are to be incorporated in the final product in what we commonly refer to as "end result specifications". The sureties have to see that the contractor is employing sufficient controls over equipment, materials and workmanship before providing the bonds.

If warranty/guarantee is utilized, the TRB Task Force membership felt that emphasis must be placed on the importance of criteria or data base for such warranty/guarantee situations. These include how the public work is intended to be utilized as well as consideration of factors such as assurances of volumes of traffic, weights of vehicles including repetition of heavy loads, the degree of regular maintenance activities being performed by the public agency and the types of materials utilized for control of such things as winter conditions, anticipated weather and soil conditions which all must be clearly spelled out within the specifications. In addition, consideration must be given to warranty/guarantee aspects in the pre-qualification process.

Expansion of use of warranty/guarantee received only a lukewarm reception from most of the contractors who participated in the TRB Task Force meetings. Most of the contractors were not enthusiastic about the use of warranty/guarantee nor did they like the shifting of responsibility that may be involved in warranty/guarantee. There was general agreement that consideration had to be given to the contractor's inputting into specifications, designs and material and equipment selection in order to be able to guarantee the performance of the end product.

The Use of Contractor Responsibility Determinations

At the TRB Task Force meetings it was discussed that government relies on, or possibly uses the contractor "responsibility" test more as a *punishment* than as a tool to sort out and rank the *quality of performance* of the various contracting entities. Within the USA we are going through a phase where many states have long lists of what "the contractor shall not do." High on that list is

antitrust activities. It is clear that proper use of pre-qualification or similar methods of measuring the contractor's past performance should be considered uniformly at all levels of government and it should involve *quality factors* and *quality performance factors* and not be a tool to punish a contractor who has gone astray.

The World Bank Experiences with Innovative Bidding

The World Bank attempted to reduce the exposure of contractors to ruinously tight pricing and elicit bids which would be closer to realistic prices. It was thought that this would allow adequate financial resources for construction as well as a fair return for the contractor's efforts. One example arises from the Peruvian regulations for bidding and contracting of public works which is aimed to achieve this through the averaging of the bids received.

An award is made in accordance with the following procedures (assuming more than three bids have been received):

1. The average of all bids and the Base Budget is calculated,
2. All bids which lie 10% above and below this average will be eliminated,
3. The average of the remaining bids and the Base Budget will then be calculated,
4. The contract is awarded to the bidder whose bid is immediately below the second average. Should none of the bids lie below the second average, the award is made to the bid which more closely approximates the average.

The intent of this procedure is to achieve fair pricing, and draw away from cutthroat competition. However, the system has important drawbacks. In the first place, bidding is transformed into a lottery of sorts, and second, concerted pricing by groups of contractors may control awards by drawing the averages towards a prearranged level.

In developed countries, the prime motivators have been political, to induce privatization of utility functions, and reducing governments' financial strains. Perhaps the most daring build-own-train venture today is that of the Channel Tunnel between England and France. For the construction of the tunnel itself, a cost plus fee contract, tied to target incentives, was used. This approach has been used for tunneling work under considerable risk. It will also include certain checks and controls not usually available, since the contractors are themselves partners in the venture, and are thus interested in minimizing the capital cost of the tunnel.

The above is some of the many foreign public works bidding methods considered by the TRB Task Force.

Seeking Quality Performance

A method of identifying and rewarding good performance is needed. Everyone wants to know how many tons of material have been put down and not the quality of the product. Quality and durability must become the targets in innovative contracting with everyone involved.

The TRB Task Force considered getting back to producing *an effective product* that is relied on by many in private enterprise and that government could use the same type of assurances found in private enterprise. This involves both performance and the final product. Such assurances have their place and should be considered in innovative contracting practices.

Use of End Result Specifications

To better understand how the uses of the various types of specifications come into play, we have to look at the common types of engineering specifications that are utilized in the United States today. One type is the materials and methods specifications. Another is the end result or performance specification and the third, I will call a quality assurance specification.

Probably the most common and often utilized type is the materials and methods specification that came out of the old system of: "if it works pretty good, why change it." Another way of putting it is, the trial and error system. These are the methods that have come out of year's of utilization and knowledge of materials and construction methods proven to have good results. Those good results are then reflected in the specification and essentially minimize the chance that a contractor could produce a product that is not acceptable. Within that type of specification, you have a lot of engineering subjective analysis. Sometimes called "engineering judgment", many times referred to in the specifications as, "As ordered by the engineer-in-charge." To a large degree, it is good old horse sense based on years of experience.

The element of substantial compliance comes into play to a large degree because there are many types of materials that may fail to meet one of numerous tests. Whether or not they are acceptable to be incorporated into the job requires that good old "engineering judgment." Of course, you are always asking, will a particular failure of one test of a multiple aspect test denigrate the performance of the whole product and will it be in substantial compliance with the requirements of the specification? Materials and methods specifications direct the contractor to use specified materials in definite proportions and then specific types of equipment and methods to place the material. I guess you could call it a "cook book" with exacting detail. This type of specification results in the contracting agency accepting the end product or result whether it is good or not.

An example of how this can be expensive to the contracting agency is when we in New York State had rutting on the Cross Bronx Expressway in New York City and it cost about \$2.5 million to re-lay the asphalt. The analysis found that the contractor used the "cook book" precisely as required, but for some reason, a large section failed.

What is lost in connection with the kind of materials and methods specification? There is no qualitative quantity level that is generally required

within the specification because the test is substantial compliance. Therefore, what is an acceptable level will vary, despite the vast knowledge and experience of inspectors.

With use of that type of specification the contractor has a very confined parameter in which to work, but if he works within that parameter and the results are bad, the government lives with the result. Therefore, the contractor's risk with that type of specification is relatively low. What are the advantages? It works most of the time. You will have an occasional failure. You shouldn't have a heck of a lot of contract adjustments for unknown factors because if there is a failure, the government is obligated to pay to correct the end result.

What is the most devastating aspect of it? The contractor can't use his own initiative because he has little option when he is told precisely what he must do, what type of materials he must incorporate and exactly how it is to be put in place. Innovation is stymied. Another drawback is that the improvement of the product will be very slight and it is doubtful that you will see a reduction in overall cost. If we were to live forever with materials and methods specifications, I suppose we would still be driving around in Model "Ts."

At the other end of the spectrum is the performance or end result specification where government does not have the risk. The risk is placed on the contractor or the supplier as to the requirement that a particular end result is produced. It comes down to the fact that you have to determine whether or not you are going to accept or reject the product at the end of the process. If you don't get a good result, you have to figure out what kind of disbenefit the contractor is going to suffer relative to the product failure or noncompliance with the end result or performance specification. There is no need in that system to have extensive inspection or sampling, but one of the basic requirements of the use of an end result or performance specification must be that the contractor is given the widest latitude possible in seeking out and utilizing new materials, techniques or procedures and defined improved construction methods in order to improve quality,

efficiency and economy in the end product.

One of the main advantages of the end result or performance specification is that you do not closely monitor the contractor's operations and should be able to save money in inspecting the project. The biggest drawback is that there are certain types of projects that just don't lend themselves to an end result specification because on the surface they can be made to look pretty darn good, but there is no real way of getting below that surface and see what is really there. Therefore, the principal detriment of an end result or performance specification is that when a defect is discovered, large quantities of material may have to be penetrated in order to correct the work and this can be very expensive.

Remember, that even though very good materials may have been selected by the contractor, he still is in control of the production and operations to place those materials and you still, therefore, may have a final product that doesn't meet the quality required in the specifications.

Design-Build Concept

An additional concept includes the "design-build" concept and the experience that Florida has had with such approach. The concept of design-build may need further research and work, including a review of statutory authorization in the particular state that wants to use Design-Build, but presents a viable option for innovative contracting.

Disputed Work Processes

The TRB Task Force considered that having a well thought out and smooth functioning disputed work process is essential and should be considered part of innovative contracting. The process must be acceptable by both government and the public works contracting community if projects are to be progressed in an orderly fashion.

Use of Privatization

The TRB Task Force considered privatization where there is a partnership between the private

sector and government. This is where there is a public facility constructed and maintained by a private entity who derives revenues through tolls. This is a concept which was very prevalent in the 1800s. With the use of modern technology and innovation, particularly when public funds are so strapped relative to public works, privatization should be considered as a viable concept in innovative contracting practices.

No Claims Clauses and Exculpatory Contract Language

An aspect that was discussed by the TRB Task Force was the use of a "no claims specification". The suggestion drew the greatest amount of fire from both the public and private sector representatives over any other suggestion made to the Task Force. There was the feeling that the no claims specification only generates additional litigation, only generates greater conflict in the field between the public agency's engineers in charge (EIC) of the job, and the contractor and affects the relationship between the EIC and the contractor. It was also suggested that the exculpatory language used by many states should be severely curtailed.

A presentation was made on the concept of why not give a percentage bonus, such as 1 percent, 1 and 1/2 percent, or something in that range, for entering into a no claims clause at the time the contract is let. It is utilized in small projects in Israel, but no one really expressed great enthusiasm in employing that as part of innovative contracting practices. However, a state may want to look at its track record relative to losses in contract claims, and depending on what kind of percentage was utilized under the bonus for no claims approach, that state may or may not want to use such a no claims bonus.

Negotiated Competitive Bidding

The TRB Task Force considered another bidding concept that is used in a limited way known as *negotiated competitive bidding*. It was suggested that the experiences of the U.S. Corps of Army Engineers could be looked at in this area and that

this concept may lend itself to possible adoption in innovative contracting practices.

Conclusion

Government has the right, as well as the obligation, to determine its own bidding system, within

the perimeters laid down by the various statutory bidding provisions, and to modify administrative processes in order to produce the best possible product for the government funds spent. Innovative contracting practices should, therefore, be tailored to existing statutory requirements while at the same time being liberally construed so as to effect desirable and needed innovative concepts.

STANDING COMMITTEE ON HIGHWAYS

Report on the National Conference on Highways and the Environment: Moving into the Mainstream

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From October 29 to November 1, AASHTO and FHWA cosponsored the "National Conference on Highways and the Environment: Moving into the Mainstream." This conference was hosted by Illinois Department of Transportation in Grafton, Illinois.

Attendance totaled 217 people, representing Puerto Rico, one person from Canada and all 50 states, including representatives from AASHTO member departments, FHWA Division, region and head-quarter staff. I am glad that I have this opportunity to report the conference results to this group because we missed some of you at the conference. The conference was designed to inform top decision makers about mainstreaming environmental issues. We had a good turnout of top environmental managers; however, only a few chief engineers and chief administrative officers were present.

The FHWA Environmental Policy Statement was used as the theme to structure the conference around. The conference was opened by Dr. Tom Larson, the Federal Highway Administrator, with his keynote address titled "Consolidating our Gains: Protecting the Environment and Enhancing the Quality of Life." You have all received copies of his talk so I will not take time here to summarize

Dr. Larson's comments. Let it suffice to say that this address set the tone for the balance of the conference.

Over the course of the two and one-half day conference several panel sessions were held that dealt with:

- The protection and enhancement of resources
- Systems planning
- The project development process
- One overall best public interest decision
- Environmental research

The issues within these larger categories are familiar to all of us and include wetlands, hazardous waste, clean air, NEPA and research. The presenters on these points were all "heavy hitters" in their field and represented FHWA, EPA, Fish and Wildlife Service, the Army Corps of Engineers, State Highway Agencies, Local Governmental Agencies, Congressional staffers and environmental groups.

Enhancement opportunities may arise in many situations and need not necessarily be related to the impacts of a proposed project.

The major conference findings and a summary of the discussions around specific issues were as follows:

Issue Area #1:

The new FHWA Environmental Policy contains a goal to "seek opportunities to contribute to a healthier and more attractive environment through the use of improved and/or innovative mitigation and enhancement measures for project impacts". The "change of attitude" needed to undertake enhancement is a broadening of the measure of public interest with which highway agencies should be concerned.

Discussion:

This goal is to be accomplished by implementing FHWA policy to protect resources, mitigate impacts, and enhance the environment to the fullest extent practicable. FHWA and the SHAs will protect resources in project situations by first considering alternatives that avoid and minimize environmental effects. When these measures are exhausted, mitigation will be implemented to restore, rehabilitate, or otherwise compensate for the impacted resources.

Whenever feasible and reasonable, the SHAs and FHWA will explore opportunities for enhancing natural resources. Exploring enhancement opportunities should become an ongoing activity of the planning and project development process. Enhancement opportunities may arise in many situations and need not necessarily be related to the impacts of a proposed project. In other instances, it may be necessary to trade off some measure of transportation utility to gain a greater measure of

public interest derived from enhancement of environmental resources.

Outstanding questions on enhancement that need to be addressed:

- How should reasonable costs of enhancement measures be determined?
- How should enhancement measures be evaluated in terms of potential effects on future actions (setting precedents, precluding future improvements, etc.)
- How far do we go in exploring for enhancement opportunities?

Issue Area #2: Hazardous Materials

Discussion:

Hazardous materials issues have become a fact of life in Project Development. Early on, highway agencies investigate for the presence or absence of hazardous materials. If present, they quantify and estimate the costs of cleanup. Highway agencies usually coordinate with public health and other regulating agencies to decide how to dispose of such materials. Generally, if a project with hazardous materials present moves forward, a highway agency develops and implements clean-up and worker and safety plans prior to construction. If the project is altered for the purpose of avoiding hazardous materials involvement, the highway agency forwards the information to health and regulatory agencies for their further action.

Hazardous materials issues have become a fact of life in Project Development.

Hazardous materials involvements are not normally considered project "impacts." Rather, the "impact" of a project is the result of early discovery

and remediation of pollution problems caused by others. In that regard, highway projects can be considered to have ancillary benefits to society, even if there are cost-recovery actions against the polluting parties.

When hazardous materials are discovered, highway agencies coordinate clean-up. They usually bear substantial costs, despite all efforts to reclaim costs from polluting parties.

Questions for Consideration:

- Should hazardous materials investigations and remedial activities be considered societal benefits of highway projects?
- Should FHWA and SHAs be willing to front-end, or even ultimately pay for the cost of hazardous materials clean-ups which are environmental enhancements of projects?

Issue Area #3: No Net Loss of Wetlands

No net loss of wetlands resources is a goal of the administration, although it is not yet a policy. These are the goal's aspects:

1. It is presumed that the goal recognizes that all wetlands cannot be avoided by transportation projects. Conversely, it is also presumed that after avoidance, when an impact minimization has been demonstrated, wetland impacts will be mitigated, while opportunities to enhance wetland values are exploited to the fullest extent possible.
2. FHWA will participate fully in individual projects in the outcomes of the process leading to the no net loss goal.
3. The goal should be pursued by sequencing decisions on wetlands as follows:
 - a. Avoid the impact.
 - b. Minimize the impact.

c. Mitigate the impact.

d. Enhance overall resource value.

4. It is more cost-effective to mitigate and enhance wetland values on a programmatic basis, rather than project by project. This program should be pursued through development of comprehensive statewide management plans that identify and prioritize wetland protection and enhancement goals.

- a. FHWA should encourage and contribute funding to establish comprehensive wetland plans, with assurances of benefits to DOT. Development of these plans should be voluntary.

It is more cost-effective to mitigate and enhance wetland values on a programmatic basis, rather than project by project.

- b. SHA mitigation plans for projects should be keyed to match priorities identified in comprehensive plans.
- c. Details of such a plan could include:
 - resource agencies identifying specific functional values that need to be protected and enhanced in specific regions, river basins, or other physiographic provinces;
 - each region, on a priority basis, defining functions in need of enhancement, such as water quality, flood control, waterfowl areas, or scenic resources;

- specific wetland enhancement proposals and projects that would increase the priority functional value.
- d. Mitigation should be keyed to a simple formula as a part of a comprehensive wetland plan—not a project by project accounting of values.

Question:

- Should FHWA fund comprehensive wetland plans without “iron-clad” assurances that eventually resource agencies will allow some form of programmatic wetland banking and functional value replacement?

Issue Area #4: Continuity between System Planning and Project Development

The system planning process should take into consideration social, economic, environmental safety, and other factors. The new Environmental Policy Statement describes the FHWA policy to integrate land use, transportation, and environmental planning, and to provide continuity between the systems planning and project development processes in addressing project needs and environmental concerns.

FHWA and AASHTO also support corridor preservation. FHWA has visited and encouraged numerous regions, divisions, and states to preserve planned transportation corridors as a way of avoiding and minimizing social, economic, and environmental impacts. This means state and local governments would have to undertake appropriate planning, NEPA process activities, and right-of-way acquisition years earlier than normal.

This does not mean that FHWA, state, or local agencies should do the necessary work to comply with NEPA and other environmental requirements two or even three times. FHWA, state and local governments should pledge to eliminate all unnecessary duplication while working together to develop transportation needs, consider various alternatives, comply with NEPA and other environmen-

tal and public involvement agreements, select the alternative, and obtain FHWA location approval under one process. This would maintain federal eligibility while accelerating project planning, development, decision making, and construction.

The following are three possible approaches which can be pursued:

1. The system planning process should only perform inventories of social, economic, and environmental factors. The NEPA process would be accomplished during project development.
2. Corridor studies should address public involvement, as well as social, economic and environmental consequences of various alternatives in a cooperative manner with federal, state, and local agencies. After local agencies have made their decisions, they should incorporate the results of the corridor studies in the FHWA NEPA document for coordination, processing and approval.
3. The NEPA analysis, documentation, processing, and approval could be performed during the system planning stage to coincide with, or represent, the corridor studies or projects in the thoroughfare plans. A phased NEPA process, not necessarily a tiered EIS, could also be employed.

Question:

- Which approach do you prefer?

Issue Area #5: (Mainly applies to FHWA) Staffing and Human Resources

Discussion:

Moving into the mainstream and implementing FHWA's Environmental Policy Statement with real enthusiasm will require a close look at organizational structure and use of personnel. This is particularly true in FHWA division offices where there

is the need to work closely with State DOTs and other agencies.

The state DOTs had to adjust their organizations and develop interdisciplinary staffing in response to NEPA such that environmental analysis and community involvement become a vital and integral part of the project development process. There is concern that FHWA has not done its part to keep pace. The field offices are still set up as they were in the 60's when design, construction and geographic monitoring were key areas and the environmental function in many areas is still relegated to a "collateral duty."

Moving into the mainstream and implementing FHWA's Environmental Policy Statement with real enthusiasm will require a close look at organizational structure and use of personnel.

There is an absence of full-time environmental staff support in the division offices. It must be realized that the environmental area is controversial, sensitive and has great exposure to other agencies and people with different philosophies, values and needs than any other program area. The people involved must have the ability to communicate effectively with many different interests while pursuing and negotiating a balanced solution to both transportation and environmental needs. It must realize that the area engineers cannot possibly be all things to all people.

These kinds of people need to be assigned to a full-time environmental staff, especially at FHWA's larger field offices, for maximum efficiency and effectiveness in implementing FHWA's environmental policy and moving into the mainstream. This would establish far greater compatibility with state DOTs while permitting a much improved interfacing with the states and other agencies. There

must be a prominent place for the environmental factors in the field organization and thus provide other agencies with a committed and trained environmental staff to work with on a day-to-day basis.

In addition, the following major recommendations of the FHWA/State Task Force on Environment must be accomplished in FHWA and states to maintain the new enthusiasm of the Environmental Policy Statement:

1. Retain the required level of environmental expertise.
2. Provide training on how to manage multi-disciplinary programs.
3. Develop a career ladder to incorporate the environmental expertise in the mainstream of agency career opportunities.
4. Allow environmental experts to participate in professional organizations and technical committees.

Issue Area #6: One Overall Public Interest

Discussion:

Virtually no one in the highway community wants anything other than one overall public interest decision on a project. We can only accomplish this with a merger of the common elements of NEPA and 404 by coordinating and combining the NEPA decision-making process with that of the 404.

Specifically, in the merger concept, there would be orderly project decision making, in consultation with the agencies, on the following elements:

1. Project need.
2. Wetlands identification and delineation.
3. Alternatives analysis.
4. Wetlands impact assessment.

5. Avoidance and minimization analysis.
6. Conceptual mitigation.

Virtually no one in the highway community wants anything other than one overall public interest decision on a project.

The merger process would require as much coordination, consultation, and agreement possible among involved agencies on the common elements of the NEPA process for EISs and EAs. The coordination process would be in the order specified, and coordination would not begin on an element until the coordination and decision-making was completed and *documented* on the preceding element. In cases where agreement could not be reached, extra efforts would be made to get consensus on decision-making. For example, a disagreement between agencies would initiate involvement of higher levels within each agency. If the decision-making could be made in this fashion, or at least achieved and documented fully, it would be difficult for any agency to prevail later with a different view in the 404 process.

Some conclusions reached from comments:

- Some states are doing the merger informally.
- Some states believe the merger cannot be done.
- Some states do not want the merger, because they are not having a problem and do not want anything "fixed."

From these conclusions it appears that states do not want a merger mandate from FHWA!

However, for those states which need assistance

trying to do the merger, FHWA should step in to help—specifically by assisting in "opening doors" at sister federal agencies. States that want FHWA to take a leadership role, and show by example how to accomplish interagency coordination and cooperation, must take responsibility for "opening doors" for cooperation at state regulatory agencies.

A note of caution. If states do not pursue the merger process, they are at risk with respect to one overall public interest decision on a project.

Issue Area #7: The Least Environmentally Damaging Practicable Alternative

Discussion:

It is the FHWA's objective to ensure that the environment is given full consideration along with engineering, social, and economic factors in project decision-making. In giving full consideration to all environmental and community factors, our attitudes are evolving into a more complete view of the environment and the way in which our projects fit into it.

This change in attitude will require a greater flexibility in application of engineering standards and possibly increased expenditure of funds to achieve a better "fit" of highway projects into the natural environment and our communities.

Some may perceive that there is a substantive difference between the balanced decision-making of the NEPA process and the "least environmentally damaging practicable alternative" of the 404 decision process. In reality, this difference does not exist because the same factors are present in both processes: namely, the natural environment, socioeconomic factors, engineering practicality, and cost. The 404(b)(1) guidelines speak to this point.

The notion that the new FHWA policy encourages profligate expenditures to overcome environmental controversy is another misconception. The policy recognizes that environmental impacts associated with highway projects can be substantial and even unacceptable to the point that some projects

may have to be abandoned. The policy is aimed at giving full consideration to environmental and community values, and at viewing the highway project as an integral part of the environment and communities that it is meant to serve.

A note of caution. If states do not pursue the merger process, they are at risk with respect to one overall public interest decision on a project.

Issue Area #8: Environmental Research

It is FHWA policy to:

- Expand the environmental research program and encourage joint research efforts and related training with environmental/resource agencies.
- Expand efforts to disseminate new information on environmental detection, protection, mitigation, and enhancement measures through the use of implementation, experimental, and demonstration projects, improved construction project documentation, and environmental training.

Newly funded research may start to restore some of the level of research of the mid 1970's. But it could be criticized as being too little when contrasted to the research budgets of resource agencies. To show serious commitment, we need to get at the broad picture of research already done, but not published or easily accessible. An early research project to index this buried research would have a high degree of support from many states and FHWA.

Questions:

- The need for this indexing effort points out the need to systematically document the research work that is done. How can we capture these earlier project studies? Also,

are there enough research dollars being allocated to transportation environmental issues?

- What would be the optimal ways of accomplishing collaboration with governmental agencies—and even the special environmental interest organizations—such as the Nature Conservancy and Ducks Unlimited?
- We have discussed the proposed approach to developing a research list. Is there something more that should be done to identify significant environmental research needs?

The notion that the new FHWA policy encourages profligate expenditures to overcome environmental controversy is another misconception.

The last half day of the conference was moderated by Hal Rives, Vice President of AASHTO, and devoted to gathering views concerning these findings. In order to have input from chief engineers and chief administrative officers, member department representatives were asked to submit written comments to AASHTO regarding conference findings. FHWA region and division offices were asked to submit their comments to headquarters.

Implementation of the Environmental Policy Statement in 1991 is a high FHWA priority. It is their position that concern for environmental issues will be of benefit in building support for reauthorization of the highway program.

All 50 FHWA division offices have responded with comments. I am sorry to report that as of the first week of December only eight member states have submitted comments to AASHTO. I have heard from a handful of other states that are working on responses. These comments will be incorporated in the Conference Proceedings which will be published and distributed.

Implementation of the Environmental Policy Statement in 1991 is a high FHWA priority. It is their position that concern for environmental is-

sues will be of benefit in building support for reauthorization of the highway program. We in AASHTO need to know where we stand in relation to the Environmental Policy Statement. This conference and response to the findings will help communicate our position to FHWA and help resolve any issues raised.

In closing, I urge you to submit your comments regarding these conference findings so that your positions will be documented and resolved if possible.

ADMINISTRATIVE SUBCOMMITTEE ON BRIDGES AND STRUCTURES

of the Standing Committee on Highways

Highway and Bridge Design: Can We Afford Aesthetics When Times are Tough?

KENNETH E. KRUCKEMEYER

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Talks about aesthetics are usually filled with pretty pictures of fancy bridges and scenic roadways. They are a pleasure to hear and see, but often seem irrelevant to the every-day pressures of work in a public agency, or for a consulting firm, where we daily deal with the nitty-gritty: the roads which are falling apart, the bridges which are corroding, and community pressures from every direction.

Aesthetics seem to be someone else's concern. In fact engineers are frequently told, and even taught, that design is not their forte. How often have you heard, or even said, "I don't *do* aesthetics," or "I don't have time for aesthetics," or "We can't afford aesthetics!"?

I hope that I can make you reconsider those remarks: so that when asked "Can we afford Aesthetics when times are tough?" you will not only answer "Yes," but "We have to!"

The Challenge

It is no secret to anyone that the pressure on state highway and transportation officials to accomplish more for less is greater than ever. At the same time that the populace is voting for lower taxes, they also continue to drive farther and farther and expect to move more and more goods via our network of highways and bridges. How do we succeed in getting more for less? More precise calculations and more up-to-date computer systems are not enough. We must respond with the most imaginative skills of the profession, and by collaborative efforts with many supporting fields.

I offer the following two examples:

1. Two bridges were designed and built in Conell, Washington, in the early 1960's. The first used standard precast, prestressed concrete girders and standard detailing. For

the second the problem was more difficult. Because of an adjacent railroad there was room for only a very shallow structure. The cast-in-place, post-tensioned slab designed by Arvid Grant and Associates used steel and concrete so much more efficiently that it cost half as much to construct. The engineering cost more, of course; but the result was lower construction costs and better aesthetics.

2. Within ten miles of each other in western Massachusetts, the Department of Public Works has reconstructed two low-volume rural roads. The first, in Charlemont, built ten years ago, used metal "bin-wall" to hold up the hillside. While solid and properly calculated, the fins have buckled, and the retaining wall will forever be a scar on the surrounding countryside. The second road, in Colrain, used a technique called soil-bioengineering to hold up the hillside. The cost was less than one-fourth the estimate for a precast concrete retaining wall proposed for the same location. The result is probably stronger, and it is certainly better looking. We will study this example in more detail later.

My first point is that *Aesthetics must be an integral part of the design.*

At the Massachusetts DPW we used to have a Bridge Architect. He was the person who was responsible for locating the state seal on the bridge and for working out the coursing of the ashlar masonry on the bridge abutments. But he retired, and that was when the interstate system was just getting underway, and it was said that "we couldn't afford that sort of decoration anyway." When visual treatment is merely additive it can just as easily be taken away. When it is an integral part of the design, as in the Conell example, it is a further reason to build the project.

The same is true for landscape work. If planting shrubs and trees are added at the end of a project to "pretty it up" then they can just as easily be re-

moved when the money is running short. But if they are essential, as in the Colerain example, then they more than pay their own way. It is when we think about the landscape at the very beginning, when wetlands are avoided rather than filled, when the topography is worked with rather than against, that a successful project is developed. Only then will a project be able to withstand the inevitable (and responsible) effort to reduce project costs later on.

Now I will agree that there are situations where it is appropriate to build a "Stage Set." Where lighting and bridge railings and sidewalk textures on a bridge are an integral part of the flavor of a particular place, such as on Howard Needles' well known bridge at Country Club Plaza in Kansas City, these added details can be very special and much loved. The funding should come from many sources, including transportation budgets. Sometimes artwork cast into the concrete can provide decoration for very little cost and it becomes an important part of the design. Deciding on what is good art, however, is an enormous challenge. "Stage Sets" are less successful when the decoration is obviously hung on the bridge and when we can peek behind the set and see the "real bridge" beneath, thus destroying the illusion.

More often, however, the beauty of the road or bridge should be found in the beauty of the project itself. The design should reflect the highest quality of the designer's and builder's skill. It should illustrate the very best solution for the problem at hand. Would we like anything less to be said of us?

Not everyone agrees with that message, however. I would like to tell you the "Parable of the Square Niche." I was responsible for the design of the Southwest Corridor Project. This project was the centerpiece for the revitalization of a swath of land in Boston which had been cleared for an interstate highway through the construction of a railroad and transit line, local street reconstruction, and the creation of a linear park. During the design phase a great deal of attention was paid to every detail, and the project has subsequently been named the "Outstanding Civil Engineering Achievement for 1988" by the American Society of Civil Engineers and received a

Presidential Design Award. Here is the story of a detail that got away.

As construction began there appeared to be a shortfall of funds when a few bids came in higher than estimated. The Construction Engineer at the time ordered that some of the design details be "simplified" to save money. One of these details was the round niches located along the concrete walls of the trackway. We had designed these recesses as a visually organized and repetitive detail, to hold various sized pieces of electrical equipment. The Construction Engineer's instructions were to make the niches square.

Upon examination, the design engineers determined, that the square niches were going to cost more because of the greater amount of reinforcing steel that would be required to prevent cracking at the corners. They reported this back to the Construction Engineer, thinking the round niches would be saved; but his reply was: "No. Make them square. They look cheaper."

So the second lesson is: *Everything we do has a message*, and I hope you will agree that cheapness is not a message which deserves to be memorialized.

One can look at streets improved with Urban Systems money and see the extraordinary difference in messages between a street which was designed merely to try to speed more traffic more quickly from point A to point B, versus a street which accomplishes the same goal while caring for the pedestrians and protecting the abutters who live along it. To take this lesson to heart the designer and the project manager must ask questions of him/herself. Not only "which design would I like to drive along?", but also "Would I like to walk my child to nursery school here?" and "Would I be happy living here?" and... "Am I proud to say I designed this street?"

The third point is that *Getting an 'A' requires more than the proper calculations*.

In school that was not the case. When the steel

beam had been sized so that the bridge would hold up the required load we got an "A". When the highway alignment provided the proper stopping sight distance we got an "A". But now that we are out in the real world we know that AASHTO requirements can be met in many different ways. Which one is the right design? Is it steel or concrete? Prestressed or post-tensioned? Do we cut into the hillside or fill into the river? What about construction impacts, maintenance considerations, schedule, environmental issues, historic preservation, community concerns, politics, funding, and aesthetics? The answers cannot be found in the tables or by simply determining the lowest possible cost.

Unless, from the very beginning, the Scope of Work describes all of the issues which must be resolved, we can very easily fool ourselves that we have the right answer. If what we have done appears to be a frivolous add-on, we will be unlikely to justify the expense to either FHWA or to the general public. Only when the problem is described in its entirety, and the solution resolves every issue, can we claim the 'A' for our efforts.

Let us look at some examples of the choices which are yours to make! They illustrate decisions which are made by engineers daily, but each one of which has aesthetic implications. Saying "I don't do aesthetics" doesn't relieve you of the responsibility for each of these decisions which are made before a project goes out to bid.

Bridges

One of the most obvious decisions about a bridge is its *color*. How often have you heard that the best thing to do with a bridge is "to make it blend in"? Well some people think a medium green works—but it doesn't! More often a dark color is successful at making something pleasant out of an ordinary design. By providing contrast with the concrete deck and the abutment the visual impact is reduced. Another trick which doesn't work is to try to hide the bridge with indigenous materials like taking stones from the riverbed. At least not when they are stuck onto the fascia or used as if we were embarrassed by the structure.

Much better, as Robert Maillart has shown in his extraordinary reinforced concrete bridges in Switzerland, is to express the structure directly. Blending is not the ultimate goal—it is gracefulness of form and truthfulness of structure which we should strive for.

A more difficult example is *celebration* because it involves the highway designer as well as the bridge designer. The vertical and horizontal alignment of the approach roadway and the bridge can either reinforce our awareness of the crossing, or it can completely obscure it. It is not just the monuments at either end of the French King Bridge, which crosses the Connecticut River in Massachusetts, which makes the experience memorable. It is also the crest which tells us we are somewhere as we reach the center and see the view up and down the river, and which honors the effort of this 1930's award-winning bridge. By contrast, the I-89 crossing a hundred miles upstream has a sag on the New Hampshire side, and as one climbs the grade across the bridge into the hills of Vermont the crossing is lost. There is no celebration in the profile. The "Connecticut River" sign and a slightly different railing are insufficient to acknowledge the work of this bridge. The highway and bridge engineers need to have worked together in an iterative process to have solved this challenge successfully.

Continuity of the structural elements is another important aesthetic consideration. All too often the approach spans to a major crossing are of different shapes and materials, possibly even produced by different engineering firms. Chorded girders may make the calculations simpler, but the visual benefits of curved girders also allow the elimination of the maintenance headache of expansion joints at every pier.

Cleanliness is a fourth virtue. Consider the difference of walking beneath the Central Artery in Boston versus waiting for a trolley under the ramps of an overpass in Dusseldorf. The steel girders and stringers of the Central Artery are homes to pigeons, drip all kinds of unpleasantness, and are dark and gloomy. By contrast the clean lines and uninterrupted surface of the reinforced concrete

ramps in Dusseldorf bounce light and provide a dry shelter. These are both examples of the early 50's—choices made by the engineers at the time. I doubt that Dusseldorf is in the same rush as Boston is to tear down its elevated highway. While both structures were designed to be strong enough to carry the loads, the German designers also properly responded to the other critical issues of aesthetics and land use.

For the crossing of I-391 over a local shopping street in Chicopee, Massachusetts, the Department wrote into the Environmental Impact Statement the requirement to create a clean and smooth underside of this bridge. Proper solutions do not happen automatically. From the beginning it is necessary to identify the goals, the aesthetic requirements which must be met by a successful design.

A final consideration for the bridge engineer is *cost effectiveness*. We fool ourselves when we think that a standardized approach will always give us the cheapest bridge. Maillart's deck-stiffened arch across the Schwandbach, built in 1933, is not only important because of its beautiful curves, but because the vertical and horizontal arches allow economies of material which were essential in this remote part of Switzerland. The Sunshine Skyway across Tampa Bay is representative of many beautiful precast segmental designs. They are also the least expensive in competitive bid. They are also often very beautiful. When cost concerns quite rightly make us put on our thinking cap, we are not being told at the same time to throw visual considerations out the window. Not at least when we know that aesthetics must be an integral part of the design.

Highways

Next, some highway examples illustrating the choices which the engineer makes and the messages which are conveyed.

Chain link fences are my favorite example because they are so often put on the drawings by the highway designer without any thought at all. And clearly they bring out the very worst in our behavior. Fencing can and should be detailed carefully

where security and longevity is important, such as protecting a heavily used rail line. At other times iron fences are called for. Vines can make the fencing into something beneficial in defining space. More often the issue is really location—can the chain link fence be put out of sight? Can it be located behind trees or shrubs, or over the edge of a hill? But the best solution is eliminating it altogether.

The highway engineer needs to be in control of the *details* by others. Because signs, signals, crosswalks, lighting and other utilities are often on different drawings, one seldom attempts to look at the accumulation of these elements and how they appear to the person driving down the road or the person walking (or trying to walk) down the sidewalk. Where is that traffic control box going to be located, and even if it is located correctly on the drawings, will it be placed somewhere else by someone in the field?

An example from California shows how a pumping station can be located in the shadows where it is not visually obtrusive, and where it does not need to be surrounded by chain link fence. Its shape, too, helps to downplay its impact. By comparison we can all think of transformers, placed in the middle of a park and surrounded by chain link topped by barbed wire. In an example from along the Merrimack River, the designer even tried to “hide” it by planting a formal row of yews around the rectangle of the fence. The trees at the corners are even a little taller, just to emphasize a geometry that should never have happened in the first place. What someone thought would make it go away has actually served to make the transformer stand out like a sore thumb.

Plan for *planting* in every job. A single weed growing out of a crack in a concrete median makes us reach for the defoliant to kill it. Consider how alternate designs can allow for natural plant growth to occur which will soften the hard materials which are a part of highway roadside work. How can we make things green where we want them to be? How can we use plants to our advantage?

Glare screens can be made of plant materials. In

Massachusetts we have used *rosa rugosa* which is salt and drought tolerant, and requires hardly more maintenance than the green metal paddles. Other plants are appropriate to other parts of the country, but they generate as much affection from drivers as “jersey” barriers destroy. The precast units used in Washington State underneath bridges allow grass to grow as far under as light and rainfall will allow. Gabions for slope reinforcement and cobbles for parking lots provide greenery in what might otherwise be solid concrete or asphalt. When this principle is applied to waterways we can allow storm runoff to move more slowly, thereby reducing downstream peak flooding and increasing groundwater recharge.

A final highway design issue is *scale*. A few years ago we hired a Landscape Architect, who had a great reputation for small gardens, to design the planting around some new welcome signs at the state line. Using a palate of local plant materials his work was picturesque, but almost invisible as you drove by at 55 miles per hour. Highway geometry can be beautiful, but it is very demanding; and the designer’s response, to try to make “blend in” by scattering a lot of little things around, is seldom successful.

For the landscape restoration of several hundred acres of cleared land at the intersection of routes 24 and I-495 a “salt and pepper” scattering of trees and shrubs throughout the project was first proposed. Instead we grouped the plantings in large sweeps which reflected the man-made geometry of the highway, and we left large areas unplanted except for seeding. The result seems lavish, but this design cost no more to implement. It successfully reflected the scale of the highway.

An Example: Soil Bioengineering

Let me conclude with an exceptional example of putting the best engineering skills to work. In this particular case the Massachusetts DPW arrived at the solution during the construction process, spurred on by soil conditions which were not as the preliminary borings had predicted, but the lessons learned here are equally applicable to projects in design.

The project is in Colrain, Massachusetts, on a rural, secondary road. The problem, I am sure, is familiar to many of you. The pavement was never really designed but merely the accumulation of tar and gravel and patches. The width between the hillside and the stream was little more than adequate for two cars to pass. And there was very little drainage or space for snow to be piled. The existing road was severely in need of repair and the town asked the state for help. The town didn't want an expressway, they just wanted a better road; and the state, of course, looked for a design which would qualify for federal aid.

The engineer's design for the project proposed a retaining wall on the uphill side to achieve the width that was desired for the roadway, shoulders and drainage. The contractor priced the concrete bin-wall at a half-million dollars. As work started, however, the location of ledge and the wetness of the slope were more problematic than had been anticipated. The estimate for the retaining wall was increased to at least a million dollars.

A young Landscape Architect on our staff proposed an alternate solution that she had been studying—Soil Bioengineering. With the help of Robbin B. Sotir and Associates, we came up with a natural solution to the problem which has cost a little more than \$200,000, less than a quarter of the retaining wall estimate; and which, after considerable doubt on the part of the designers and construction engineers in the Department, has generated a great deal of confidence. Here is what we did:

The slope was laid back at a steepness ratio of one and one-half to one (not a great deal farther than would have been necessary to build the retaining wall, given the difficulty of establishing a proper foundation for the wall on the ledge). A base of crushed stone was established and drainage was installed. Last winter, plant materials, primarily willows and dogwood, were harvested from nearby flood control dams and power line and highway rights-of-way. A geotextile and crushed stone layer was placed on the hillside, and the brush was layered horizontally between compacted four-foot lifts

of fill from the hillside. This created a mechanical network to hold the hillside and reduce erosion during the winter and spring. This past summer, as the plants have leafed out, they have also established a dense network of roots to hold the soil and to pull the wetness out of the hillside. Over time, these plants provide a good environment for oaks, maples and pines from the uphill forest to reseed the slope. Being shaded, the willows will then die back and a mature forest will have been reestablished, permanently holding the hillside.

Why is this such a special project? First, it costs less. Second, it uses local labor and materials. Third, being both flexible and natural, it is probably stronger and more permanent than the retaining wall, which would have had to continually fight against water in the hill and the corrosion of time. And, finally, it looks better! What better way to build pride in the town, in our state, and in our highway system.

Conclusion

Pride can go a long way. Who is going to throw out a candy wrapper at a rest area that is as well cared for as many are in Michigan with their well-kept beds of flowers? Who would dare cover the brickwork with graffiti? By contrast think of some common examples from highway and bridge projects. We might not be into graffiti or prone to throwing candy wrappers on the street, but aren't we all put off by the ugliness of a splotchy wall of plain concrete, and angered by the twisted top of a chain link fence which reaches out to tear our jacket?

In each of the things which we design and build, and maintain, there is a message. It tells something about ourselves and about how we hope others will behave. If we care about these things, then we have to start with the message that aesthetics count; that our surroundings are important.

How would you like to be remembered? With the same tools at your disposal you can either be the creator of chaos, or of good design. Can you afford not to care about aesthetics?

HIGHWAY SUBCOMMITTEE ON CONSTRUCTION

of the Standing Committee on Highways

Quality Concrete Pavements—Ingredients to Success

THOMAS A. BRYANT, II
State Engineer, Arizona Department of Transportation

The Arizona Department of Transportation (ADOT) is committed to designing, constructing and maintaining a new State funded Metropolitan Phoenix Freeway system. The freeway system was authorized by a vote of the people of Maricopa County in 1985. The vote authorized the collection of a one-half cent county sales tax over a 20-year period to build approximately 231 miles of new urban freeway. Total cost to design and build is presently expected to be \$6.3 Billion. Since sales tax funds can be used for construction only and not for maintenance, concrete quickly became the choice for the pavement. To design and construct such an ambitious plan, ADOT has had to be innovative in all facets of the process. The degree of success of this enterprise will be measured in efficient use of funds, timely completion and system performance. A quality concrete pavement is absolutely necessary to convince the traveling public that the department has successfully completed the freeway system.

Background

ADOT constructed its first major PCCP in the mid 1950's. With the beginning of the interstate

highway system in the late 1950's, Arizona's concrete pavements were constructed 8-9 inches thick on top of an aggregate base 6-18 inches thick. Asphaltic concrete paved shoulders over an aggregate base were constructed adjacent to the concrete pavement.

A quality concrete pavement is absolutely necessary to convince the traveling public that the department has successfully completed the freeway system.

The concrete mix utilized six sacks of cement, with a 2 to 3 inch slump and 5 percent entrained air. The concrete attained a 3,000 psi 28-day strength. Coarse aggregate was a 2-inch upper size. Joints at 60 feet contained a steel strip 2 1/2 inches wide and a maximum of No. 12 gauge. Steel inserts were either placed by hand or machine. In between

the 60-foot joints, sawed joints were placed 15 feet apart. These joints were cut 2 inches deep and the width could not exceed 3/16 inch. A burlap drag was used to provide texture for skid resistance. Surface smoothness was controlled by a 10-foot straight edge that could not vary by more than 1/8 inch. Overall quality control of the concrete was described in the following manner, "frequent tests for compression, slump and air content shall be made of the concrete mixture."

As the years progressed concrete pavement design and construction changed. In the early 1960's, ADOT adopted the use of the California Profilometer to control smoothness. By 1966, steel inserts at the 60 foot joints had been eliminated and replaced by sawed joints. By 1970 all transverse and longitudinal joints were sawed and shaped in such a way as to provide for a sealant reservoir. The concrete slump requirement became one to three inches and the air entrainment became four to seven percent.

In 1975, tied concrete shoulders replaced asphaltic concrete shoulders. Also, cement treated base replaced aggregate base. The 28-day compressive strength was raised to 4,000 psi. Longitudinal nylon brooming was specified for the concrete texture to improve skid resistance.

In the 1980's type IP Portland-Pozzolan cement with fly ash came into common use for concrete paving. The slump limits changed to 0-4 inches. The concept of water cement ratio, contractor supplied mix design and statistical specifications began to appear. Constant temperature water curing tanks began to be used at the field level to better control cylinder breaks. In 1984, the concrete thickness was increased to 10 inches and dowels were placed at each transverse joint. In addition transverse tined texturing was required in order to improve surface water drainage and skid resistance. The coarse aggregate top size grading became one inch. Lean concrete base replaced cement treated base.

In 1986, the new *AASHTO Pavement Design Guide* was issued and implemented in Arizona. This design procedure, coupled with new traffic loading information and improved forecasting, led

to thicker pavement designs of 11-14 inches of concrete. Since base course thickness became less of an issue under the new guide, it has been viewed more as a construction platform. Either primed aggregate base or asphaltic concrete base are placed (see attached guideline). In addition, the base is placed three feet beyond the edge of the concrete paving to facilitate the stability of the paving equipment track. In 1988 silicone sealant was specified for joint sealing. Also, changes in the specifications called for the contractor to provide a quality control plan and in general exercise greater quality control responsibility.

Performance/Design innovation.

Many improvements in concrete pavement design and construction have taken place and overall performance has been the better for it. As a result of these changes, several factors contribute to such good performance in the Phoenix area including, the dry, no freeze climate and good materials. Nevertheless, pavements do wear out and deteriorate over time as traffic loading increases. Since the interstate system began in 1958, the annual 18 kip equivalent single axle loads (ESAL's) have increased 35 fold. As an example, in 1958 the I-10 loading was 70,000 18 kip ESAL's per year. Presently, it is 2,400,000 18 kip ESAL's per year. Not surprisingly, the early interstate concrete paving projects became very rough due to poor joint design and lack of a good smoothness specification. In addition the Burlap Drag Surface Texture was not adequate and surface polishing occurred rapidly, thus causing low friction values. Virtually all of the 1960 interstate concrete pavements have been significantly rehabilitated or reconstructed in the 1980's. With the introduction of tied concrete shoulders in 1975 and all of the other improvements in joints, surface texture and thickness concrete pavement performance has been very good.

In order to better understand this performance a series of projects with various pavement thickness were built in the 1970's on State Route 360, the Superstition Freeway. James P. Delton reported in 1981 on this work at the Second International Conference on Concrete Pavement Design in a paper

entitled *Non-Conventional vs. Conventional Concrete Pavements in Arizona*.

Subsequent follow-up reviews, including a recently completed 1990 research study entitled *Evaluation of Concrete Pavements in the Phoenix Urban Corridor*, by ERES Consultants, Inc. showed that thick full depth sections (11–13 inch) built at a reasonable initial specification roughness have provided the smoothest long-term ride with no routine maintenance. Adjacent sections of 9-inch concrete on CTB started out rougher and continued to increase in roughness, although maintenance costs have also been very low. Another adjacent section of 6-inch prestressed concrete on lean concrete base was initially built very rough. Deterioration of joints contributed to more roughness and maintenance costs.

With the recognition that pavement smoothness is the most important quality to the traveling public, greater emphasis has been placed upon it.

With the construction of the new freeway system, ADOT reviewed concrete pavement performance in the state and applied this knowledge to the use of the new 1986 *AASHTO Pavement Design Guide*. In addition, greater emphasis has been placed on quality construction. Thus, ADOT is using pavement design and construction practices directed at constructing a quality pavement where pavement smoothness, cracking and skid resistance problems are minimized and service performance maximized. To do this various typical PCCP alternate designs including 11–14-inch plain jointed concrete, 10–13.5-inch doweled plain jointed concrete and 9–12-inch continuously reinforced concrete designs are reviewed using an innovative life-cycle cost method and compared to representative asphaltic concrete designs in a like manner. All of the above sections have been designed or built in the last five years. The result of this work has been the design and construction of a diverse cross section of concrete pavement.

Construction Innovation

Along with design improvements, construction methods, specifications and equipment have also improved. With the recognition that pavement smoothness is the most important quality to the traveling public, greater emphasis has been placed upon it. An innovative ride bonus specification has generated an incentive for the contractor to build a smooth pavement. The contractor can earn a one dollar per square yard bonus by keeping the ride under 2 inches per mile. In order to meet this new specification and avoid expensive grinding costs, contractors have invested in new paving equipment. Such pavers as Gomaco Model GP 2500B, GP 3000 and GP 3500 as well as CMI SF 550 and Guntert Zimmerman pavers are commonly in use.

As stated earlier, tied PCCP shoulders are incorporated into all construction except for the median shoulder where asphaltic concrete is utilized to allow for ease of removal for future additional lanes. Recently, silicone joint sealers and their special reservoir design became standard. Transverse fine texture continues to be the standard. Statistical quality control governs all concrete work. These controls have been extended to the contractor's operation by requiring a quality control plan, NICET certified technicians and an AASHTO Accredited Materials Laboratory be on the project. Additionally, the specifications require the contractor to submit a process quality control plan for approval. The quality control plan is administered by the contractor and provides the contractor considerable freedom in conducting the plan and performing mix designs. ADOT monitors the quality control plan, verifies mix design and does the acceptance testing. A pre-paving conference is held on each concrete project.

This conference goes into detail about the importance of good equipment, quality aggregate, cement and other products. All other aspects of the project are reviewed to ensure high quality.

Summary

As an example of ADOT's approach to concrete pavement design and construction, an eleven-mile-long section of Superstition Freeway was recently awarded and is currently under construction. The pavement section consists of 13 inches of plain jointed concrete on a 4-inch primed aggregate base. The concrete pavement includes a tied shoulder, transverse tine texture, sawed joints with a silicone

sealant, statistical quality control, ride bonus contractor quality control, a pre-paving conference and state-controlled quality assurance and yet the cost of the pavement was very reasonable at \$13.52 per square yard. ADOT is committed to quality pavements whether concrete or asphalt and will continue to design and build in an innovative manner with performance, durability and service to the traveling public as the primary goals.

HIGHWAY SUBCOMMITTEE ON HIGHWAY TRANSPORT

of the Standing Committee on Highways

Advantage I-75

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As a result of rapidly developing electronic technologies and control systems, Intelligent Vehicle/Highway Systems (IVHS) promise a cost-effective alternative for enhancing the nation's future mobility. As a result they are expected to play a significant role in the post-Interstate highway program, supplementing road construction, transit expansion, and other more traditional means for accommodating increasing travel demands—safely and efficiently.

At the same time, prospects for truly interactive, real-time communication with nearby vehicles and with roadway sensors and control systems add a whole new dimension to the task of providing and managing the highway infrastructure. No longer will it suffice to simply assure that the infrastructure is physically compatible with the vehicles that use it, that the lanes are wide enough, the pavement is strong enough, the curves are banked enough, or the grades are flat enough.

The immediate benefits of ADVANTAGE I-75 to motor carriers—faster delivery time, lower operating costs, and energy savings—result from reduced stopping.

Instead, with IVHS, drivers, vehicles, and roadway will be electronically linked by sophisticated systems for sensing, communication, computation, and control. Transmitted information will be precise and timely, indicating actual travel and roadway conditions. Driver displays and other cues will optimize driver performance while minimizing human error. On-board instrumentation will carefully match roadside electronics. Control systems will reflect the dynamics of car and roadway interaction. In short, the driver/

vehicle/roadway system will be genuinely integrated as never before.

To realize these ends will require unprecedented coordination between vehicle manufacturers, equipment suppliers, and highway providers. The states/provinces will have to work closely together to avoid duplication and to promote common objectives and standards. New lessons will have to be learned about the process of converting our nation's roads and streets into electronic thoroughfares. Taking an initial step and knowing how to nurture that process—while both technology and its potential applications evolve rapidly—will be a major challenge.

The purpose of this paper is to present *ADVANTAGE I-75*, a concept based on the premise that some IVHS technologies are now well advanced and that early benefits can be realized by their application in the highway environment. *ADVANTAGE I-75* focuses on IVHS implementation, not development, and on the processes whereby technological advancements are assimilated into the operational setting. It is an initial step in the process of adapting the nation's highway system to accommodate the increased traffic demands placed upon it by taking advantage of the rapid advancements in electronics technology and its applications.

ADVANTAGE I-75

ADVANTAGE I-75 represents a partnership of public and private interests in the I-75 corridor. Its goal is to reduce congestion, increase efficiency, and enhance safety of motorists and other users of I-75 and its connections into Canada through the application of advanced highway and vehicle technologies.

The key features of *ADVANTAGE I-75* that combine to distinguish it from other IVHS ventures include the following:

- Initially small in scale but incrementally expandable;

- Emphasis on implementation;
- Utilization of proven, off-the-shelf technology;
- Decentralization of control through a state/provincial partnership;
- Maximum reliance on existing agencies and institutions and on existing statutes and regulations;
- Close cooperation between public and private sectors; and
- Shared funding responsibility among federal and state/provincial agencies and the private sector.

Motor-Carrier Project

Currently being considered as the inaugural project of *ADVANTAGE I-75* is an application of automatic vehicle identification (AVI) technology designed to facilitate motor-carrier operations by allowing transponder-equipped and properly documented trucks to travel any segment along the entire length of I-75 at mainline speeds with minimal stopping at enforcement stations.

Preclearance decisions at downstream stations would be based on truck size and weight measurements taken upstream and on computerized checking of operating credentials in each state. Under *ADVANTAGE I-75*, each state retains its constitutional and statutory authority relative to motor carriers and their operations.

Key features of the motor-carrier project include the following:

- Early and tangible benefits are expected for motor carriers, the traveling public, and state/provincial agencies;
- Implementation can proceed immediately because feasibility of the technology has already been established;

- Implementation and operational costs are modest;
- Considerable opportunity exists for expanding the project incrementally as early success is realized and as more sophisticated technologies are perfected;
- Little or no institutional or statutory change is required to implement and operate the project; and
- Expansions into interconnected corridors and other geographical regions can easily be accommodated.

System Description

As currently envisioned, the system would operate as follows. Each transponder-equipped truck entering the corridor would be weighed and inspected at the first open enforcement station and operating credentials would be checked by computer. Necessary trip-specific information (truck identification, axle weights, etc.) would be immediately transmitted in a basic data packet to the next downstream station. Upon reaching that station within a suitable time window, the truck would be identified by AVI equipment and, if precleared, would be individually directed to bypass the station. The basic data packet would be updated with the time of passage before being transmitted to the next downstream station to repeat the process.

The overall concept is intended to focus and build on the important characteristic of decentralized control and management. Each state/province would maintain its distinctive motor-carrier database, making minor changes only as necessary to accommodate common information needs. A limited amount of common or core information, the basic data packet, would be transmitted from station to station. The data packet would contain trip-specific information such as the vehicle identification number, axle spacings, axle weights, truck configuration, the time of entry into the system, and the time of passage at the prior enforcement station. It is anticipated that the communication system would

provide real-time data relay between adjacent stations along the corridor. The examination of operating credentials, when necessary for preclearance at the downstream station, would be accomplished by computer. On-site personal computers could be used or communication links could be established between each station and the state's/province's central database. The use of on-site computers would necessitate procedures for frequent updates of the local database to ensure that data used to validate operating credentials is current.

One of the possible hardware alternatives being considered would require three readers or transceivers at each enforcement station. The first, located on the mainline in advance of the station, would identify approaching, transponder-equipped trucks. For trucks just entering the I-75 system, receipt of a signal by this reader would trigger the initial computer validation of operating credentials. For each other truck, a check would be made to ascertain if the vehicle had been precleared and, accordingly, should be instructed to bypass the station.

A second mainline reader would be needed at each station to verify the passage of properly precleared trucks. A signal (light, sound, or computer display) would simultaneously alert the enforcement station personnel that the bypass has been authorized.

A third reader would be required on the station entry ramp to enable a ready match between the identification number of each newly entering truck and its size and weight measurements. This is the transceiver that would trigger the creation and transmission of a new basic data packet for each entering truck.

Under *ADVANTAGE I-75*, each state/province would retain its traditional responsibility and authority for motor-carrier monitoring and enforcement activities.

Benefits

ADVANTAGE I-75 is envisioned as an incremental process in which progressively more advanced

technology is installed along I-75 as it becomes available for implementation. The proposed first phase—facilitating the movement of trucks by eliminating unnecessary stopping for weighing and inspection—was conceived as a relatively low cost, readily implementable activity. Nevertheless, motor carriers, the travelling public, and state/provincial agencies are all expected to realize immediate benefits.

The travelling public would benefit from the motor-carrier project through reduced congestion and enhanced safety in the vicinity of enforcement stations.

The immediate benefits of *ADVANTAGE I-75* to motor carriers—faster delivery time, lower operating costs, and energy savings—result from reduced stopping. While the savings are usually small for any one stop, the accumulation of benefits is expected to be significant for frequent users of the corridor. As *ADVANTAGE I-75* matures and technology advances, the frequency of inspection stops would be expected to diminish even further with concomitant reductions in travel delays.

Off-roadway benefits, reduced paperwork and increased uniformity, are expected consequences of future technological advancements and the dialogue made possible by the *ADVANTAGE I-75* partnership. *ADVANTAGE I-75* has already focused considerable attention on off-roadway obstacles to efficient motor-carrier operations, especially those stemming from non-uniformity in state/province statutes, regulations, and procedural requirements and from voluminous paperwork requirements. As *ADVANTAGE I-75* matures and as an effective private-public partnership evolves, increasing attention to institutional issues can be expected. Although substantial progress may not come quickly, both private and public sectors would reap large gains from a streamlined regulatory system. *ADVANTAGE I-75* may prove to be an effective way to accelerate this end.

The travelling public would benefit from the motor-carrier project through reduced congestion and enhanced safety in the vicinity of enforcement stations. Maneuvering would be less as fewer trucks would be required to exit and reenter mainline traffic. Furthermore, each truck bypass would lessen the probability of a queue backing up to the mainline. The general public would also eventually benefit in the pocketbook as a result of lower prices stemming from the more efficient movement of goods.

Agency functions impacted by the deployment of AVI equipment include planning, vehicle enforcement, general law enforcement, emergency response, and revenue. Initially, the primary benefit of the motor-carrier project to the state/provinces will likely be to increase the effectiveness with which such functions are performed. The states/provinces will likely be unable to immediately capture cost savings resulting from small, incremental improvements to the truck and motor-carrier monitoring process. States/provinces would be expected to profit most by increased use of electronics in data generation and processing. Ultimately, *ADVANTAGE I-75* could fundamentally change the way motor carriers and the states/provinces do business with one another, promising to reduce the costs to both.

Certainly advanced technology is not a substitute for construction and other means for achieving these ends but it is an essential complement.

The real benefits of *ADVANTAGE I-75* are likely to be long term. Although the states/provinces will share the benefits of the motor-carrier project with the truckers and the travelling public, the greatest potential of *ADVANTAGE I-75* is in hastening the implementation of a broad range of advanced technologies as a means for maintaining mobility, increasing productivity, and enhancing highway safety. Certainly advanced technology is not a substitute for construction and other means for achieving these ends but it is an essen-

tial complement. Under the advocacy of *ADVANTAGE I-75*, users of I-75 could become the first day-to-day beneficiaries of the applications of progressively more sophisticated technology in the highway environment.

Organization

The genesis of *ADVANTAGE I-75* can be traced to a meeting in June of 1990, attended by 135 representatives of individual motor carriers, national and state trucking associations, six I-75 state governments, two Canadian provinces, the U.S. and Canadian national governments, equipment suppliers, and other interested parties. Following the conference, a Policy Committee endorsed the incremental application of advanced technology in the I-75 corridor and appointed a subcommittee to consider institutional concerns related to the motor-carrier project.

The *ADVANTAGE I-75* Policy Committee continues to provide overall guidance and direction. Its membership of 20 includes state and national officials as well as motor-carrier and trucking association representatives. The Subcommittee on Institutional Concerns has 16 members including a governmental and motor-carrier representative from each of the six I-75 states, three representatives from Ontario and Quebec, and one representative from the Federal Highway Administration.

Additional committees may soon be needed for in-depth examination and resolution of other developing aspects of *ADVANTAGE I-75*. In addition, annual or biannual conferences, dedicated to exploring new applications of advanced technology in the I-75 corridor, have been proposed as an attractive way to provide long-term continuity and direction. Although it is hoped that the success of *ADVANTAGE I-75* will not demand significant new "institutionalization," continual organizational evolution is expected in response to new challenges and more clearly articulated needs.

Staff support for *ADVANTAGE I-75* is currently being provided by the University of Kentucky Transportation Center under auspices of the

Kentucky Transportation Cabinet.

State Role

A distinguishing feature of *ADVANTAGE I-75* is the discretion that each state/province has in determining how it would interface both with the other states/provinces as well as with the motor carriers that travel within its boundaries. Such discretion is essential because of differences among the states/provinces in their motor-carrier statutes and regulations, in their historical approaches to truck monitoring, and in the degree of their automation of the truck monitoring function. Thus, the initial phase of *ADVANTAGE I-75* attempts to accommodate the diversity that exists among the states/provinces rather than to demand uniformity.

A minimum commitment to the motor-carrier project of two years is expected.

Initially, participating states/provinces will be expected to embrace the *ADVANTAGE I-75* concept; to generate and transmit basic trip data for use by other states; to use data generated by other states in the screening that precedes preclearance decisions; to embrace an automated system for real-time checking of key operating credentials of truck and carrier; to share responsibility for managing *ADVANTAGE I-75* including the entry, registration, and withdrawal of motor-carrier participants; to seek, together with I-75 motor carriers, to implement other ways for improving trucking productivity; and to seek, in a continuing dialogue with others, new ways to apply emerging technology in the I-75 corridor.

Participation in *ADVANTAGE I-75* also entails a financial commitment by the states/provinces. Initially, costs would focus on hardware procurement and installation, database and communication systems development, and training. Although there would be differences among the states, the largest component of operating cost is likely to be in

maintaining the computerized database. Maintenance of the hardware and communication charges are other operating-cost components of likely consequence.

A minimum commitment to the motor-carrier project of two years is expected. In the long term, participation in *ADVANTAGE I-75* involves a further commitment to work with others in the corridor to continually enhance motor-carrier productivity and, more generally, to reduce congestion and improve safety for all motorists through the application of advanced technology.

Motor-Carrier Role

The partnership that is being formed consists of individual motor carriers, possibly other private industry, state/provincial agencies involved in monitoring truck operations, and the Federal Highway Administration. An obvious key to successful deployment of AVI along the I-75 corridor is the commitment and participation of motor carriers. Although frequent and possibly long distance users of I-75 stand to benefit most, any fiscally responsible motor carrier with a satisfactory safety record and an interest in *ADVANTAGE I-75* is encouraged to join the partnership. At the same time, it appears that practical considerations may delay the inclusion of certain operations, for example, those involving trip leasing, oversized/overweight loading, permitted vehicles, hazardous materials, and agricultural commodities.

An obvious key to successful deployment of AVI along the I-75 corridor is the commitment and participation of motor carriers.

Nevertheless, progress currently being achieved in coordinating requirements for the permitting of oversized/overweight loads offers promise that the transport of such loads may become one of the first significant enhancements to *ADVANTAGE I-75*.

Furthermore, very real safety benefits could result from the installation of transponders on HAZMAT transporters. This is expected to eventually happen as confidence concerning the safety impacts of *ADVANTAGE I-75* builds. Eventually, there should be little, if any, need to exclude specific operations, carriers, or commodities.

Over time, the states/provinces would be expected to move much closer together in the kind and extent of information collected.

For now, those joining the partnership are expected to be seriously interested in the *ADVANTAGE I-75* concept and likely to continue into the implementation phase. They are encouraged to participate in the planning and development process. Eventually, each motor carrier would be expected to operate an agreed upon number of trucks for a minimum period of two years, to provide transponders at its own expense, and to participate in evaluating the impact of *ADVANTAGE I-75* on its operations and costs

Extent and Type of Monitoring

The differences among the states/provinces in their monitoring of trucking and motor carriers—the intensity of monitoring activity, the type of roadside equipment and facilities, the level of committed resources, the missions of the principal agencies, etc.—are quite significant. Clearly, it would be difficult, if not impossible, to inaugurate *ADVANTAGE I-75* if nearly identical requirements were initially placed on each state/province.

Perhaps more importantly, the *ADVANTAGE I-75* system is not jeopardized even with quite different operations from state to state. For example, no change would be required in the hours of operation of enforcement stations. As is current practice, trucks entering I-75 would stop at the first open station and would bypass all closed stations. How-

ever, at the discretion of each individual state/province, AVI truck passages could be automatically monitored at closed stations, and information from the basic data packet could be collected for planning and design purposes.

As a second example, suppose provisions had not been made at an entry station for adding axle spacings to the basic data packet. Each truck entering I-75 in that state/province might be allowed unimpeded bypass of other stations in the same state/province but would be required to stop in the adjoining state/province for remeasurement of axle spacings.

Over time, the states/provinces would be expected to move much closer together in the kind and extent of information collected.

Setting a limit to the maximum time to travel from one station to the next is a reasonable way to discourage enroute changes in loading and configuration. A lenient limit—such as time to travel each segment at 10 mph slower than the posted speed limit plus one to one and one half hours for eating, fueling, congestion delays, etc.—would likely accomplish this objective without encouraging speeding. Actually, the limits could be quite flexible, differing for different times of the day or days of the week and perhaps accommodating unusual weather conditions as well. For truckers experiencing very large enroute delays on a particular segment, the one-time penalty, a stop at the next enforcement station, should not be burdensome.

In support of Federal hours-of-service requirements and in recognition of the potential danger of driving while fatigued, participating truckers who had been traveling on I-75 too long—for example, in excess of six hours—would be directed into the next enforcement station.

Data Certification

Preclearance at downstream stations is viable only when the transmitted information is sufficient to enable accurate preclearance decisions to be made. Because of the uniformity of size and

weight restrictions on the Interstate system, some have suggested that it might be easier to simply transmit the fact that a truck is in compliance rather than to transmit raw size, weight, and configuration data.

At issue here is not so much the ease of data transmission as it is with the state/provincial role in monitoring truck movements and in enforcing motor-carrier regulations within its own boundaries. *ADVANTAGE I-75* builds upon the principle that the traditional state/province role should remain unchanged. In keeping with that principle, “authority to operate” decisions can not be made by one state/province for operations in another.

It is important to add that truck weight is limited not only by the uniform legal maximum established by Federal law but also by the weight at which the truck is registered to operate within each state/province. With decentralized databases, states/provinces won’t have access to the registered weights of individual trucks in other states/provinces and, hence, won’t be able to determine compliance or noncompliance.

Finally, size and weight data are needed for planning and design as well as enforcement purposes. Knowing that a truck is or is not in compliance is no substitute for the raw size and weight data necessary, for example, to design pavement structures or to determine optimal pavement maintenance strategies.

While it is unrealistic to expect a state/province to accept another state’s/province’s certification of operating authority, acceptance of truck size and weight data is another matter. In this regard, a definite distinction is made between the use of weight data for enforcement purposes and its use for preclearance screening. Most states would be expected to require the use of static scales, calibrated according to Handbook 44 requirements, as a basis for enforcement actions. At the same time, many ought to be willing to accept the use of weigh-in-motion (WIM) scales (either low-speed or high-speed) as a basis for preclearing or sorting, allowing trucks to bypass static scales unless their loading was questionable.

The notion has been that a state/province could choose to reweigh trucks which appeared, based on measurements taken by another state/province, to be loaded near the legal limits. The decision to reweigh might depend on the kind of scales used for the initial weighing and, perhaps, on scale-calibration standards. Over time, the states/provinces would develop the kind of experience with other state's/province's data that would permit informed decision making, and the frequency of reweighing would be expected to diminish rapidly.

Technology Base

The *ADVANTAGE I-75* philosophy has very much been that its initial project should be as narrowly focused as possible. The challenge, it was felt, was to form a working partnership among the states/provinces, national governments, and a variety of motor carriers. The prospects for success were reasoned to be much greater if the initial project were relatively small, relatively inexpensive, relatively uncomplicated, and capable of rapid implementation.

AVI technology is well developed, well tested, and suitably inexpensive for *ADVANTAGE I-75* application. Although high-speed WIM and other technologies are developing rapidly, no other technology is better suited to an initial application through *ADVANTAGE I-75* than AVI. Furthermore, AVI technology is expected to be a cornerstone of virtually every application of advanced technology to truck monitoring. That is, an initial application built around AVI technology would comprise the essential element from which more sophisticated systems would evolve.

Some may argue that *ADVANTAGE I-75* should be postponed pending the development of national/international standards for AVI equipment. Although work toward the development of such standards is currently under way, questions remain about 1) when the work will be completed, 2) whether there will be a single standard or multiple standards, 3) whether the standard will be national or international, 4) whether the standard will be able to accommodate developing technology, and 5) whether

the standard will encompass the kind of application envisioned in *ADVANTAGE I-75*. It seems unwise to postpone the benefits of *ADVANTAGE I-75* on the assumption that there will soon be universally accepted standards for AVI technology. Furthermore, as *ADVANTAGE I-75* evolves, new requirements are likely to be placed on the system. Early experimentation with the technology is desirable in order that refinements can be made in its application.

Over time, the states/provinces would develop the kind of experience with other state's/province's data that would permit informed decision making, and the frequency of reweighing would be expected to diminish rapidly.

It may be helpful to recall that the real purpose of *ADVANTAGE I-75* is not the development of new technology but rather the development of useful applications for that technology, and the creation of an environment within which proven technology can be quickly implemented to simultaneously benefit both road users and public agencies. A great opportunity could be lost if *ADVANTAGE I-75* chose to focus on the development of technological standards or chose to delay the development and implementation of applications pending standardization.

ADVANTAGE I-75 cannot assure that the AVI technology it selects will not become functionally obsolete. Given the rapid pace of current technological advancement, the clear expectation going in must be that improvements will be made during the immediate months and years ahead. To protect the investments of all the partners, however, commitments should be made to use initial AVI procurements for a period of at least two years. After that—as with other rapidly advancing technologies including computer and communication systems—the possibility of change must be realized.

The incorporation of mainline WIM and automatic vehicle classification (AVC) has been suggested as a possible refinement that should be embraced initially by *ADVANTAGE I-75*. However, the development of high-speed weigh-in-motion may not have yet reached the stage where it is ready for widespread *implementation* in an operational environment, although current technology is sufficiently accurate for presorting purposes. Incorporating mainline WIM and AVC in the initial phase of *ADVANTAGE I-75* would significantly add to its cost and complexity and unnecessarily delay its implementation.

Any state/province wishing to use mainline WIM and AVC to monitor truck traffic along I-75 would be encouraged to do so. When *ADVANTAGE I-75* is ready to embrace and implement mainline WIM and AVC technologies, the basic AVI and communication system would already be in place to accommodate them: the prior investment would not be lost.

For a number of years, the Heavy Vehicle Electronic License Plate Project (HELP) has successfully advocated the application of advanced technology to the enhancement of motor-carrier operations, and HELP's current demonstration, Crescent, promises to demonstrate the utility and practicality of its prior developments. *ADVANTAGE I-75* is considered as a complementary not competitive activity to HELP. Delaying *ADVANTAGE I-75* until the Crescent demonstration has been completed would seem to offer few, if any, benefits. On the other hand, by beginning its activity now, *ADVANTAGE I-75* would be much better postured to assimilate Crescent's most promising findings as soon as they become available.

A critical characteristic of *ADVANTAGE I-75* is its ability to expand—geographically, functionally, and technologically. Listed below are some of the near-term extensions that could be considered:

- Congestion could be monitored using the instrumented trucks as real-time traffic sensors;

- Properly equipped trucks with on-board computers could spot electronic markers placed at significant roadside locations including state/provincial boundaries;
- Eventually drivers' logs could be extensively automated;
- An additional transponder, credit-card sized, could identify the date of the most recent Commercial Vehicle Safety Alliance (CVSA) inspection or the date could be entered into each state's database for computer checking;
- High-speed WIM and AVC—logical future expansions of *ADVANTAGE I-75*—could be easily incorporated by any state/province;
- Each state/province could build upon the basic system in ways unique to its needs;
- The movements of hazardous materials could be tracked by equipping HAZMAT trucks with AVI transponders;
- Geographical expansion to other routes and jurisdictions could be encouraged; and
- New and enhanced technology could be adopted as it becomes available for implementation.

Evaluation

An evaluation plan is an important element of the motor-carrier project. Because the project would primarily involve existing technology, the focus of the evaluation would be on functional issues that affect motor carriers and state/provincial agencies. In addition, subjects to be addressed by the evaluation include the following:

- Operating environment in which equipment functions accurately,
- Savings to motor carriers,

- Benefits to state/provincial agencies,
- Progress toward greater uniformity,
- Reduction in congestion, and
- Enhancements to motorists' safety.

Timetable

The objectives of current work are to form a partnership of states and interested motor carriers, to refine the *ADVANTAGE I-75* concept to the satisfaction of government and industry, and to lay the groundwork for developing detailed plans and specifications.

If current schedules can be met, the motor-carrier project could be fully operational as early as July 1, 1992. To meet this target, however, funding must be committed and detailed plans and specifications must be developed by mid-September 1991.

Conclusions

ADVANTAGE I-75 is very much an experiment in the collective ability of a group of states/provinces to effectively enlist IVHS technologies in the campaign against growing highway congestion and threats to public safety. The initial emphasis has been placed on motor carriers both because intense market pressures underscore the essential productivity benefits to carriers and because of the advanced state of trucking-related technologies.

With time, the motor-carrier project is expected to grow—technologically, functionally, and geographically—and other IVHS applications are expected to be set into motion along the I-75 corridor. Whether such expectations are realized or not, however, important lessons will have been learned about the implementation of advanced-technology solutions to pressing problems of highway travel.

HIGHWAY SUBCOMMITTEE ON HIGHWAY TRANSPORT

of the Standing Committee on Highways

Advantages of Oversize/Overweight Truck Permit Uniformity

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A major national effort is underway to develop common state procedures for issuing permits for routine, non-divisible oversize/overweight trucks engaged in interstate travel. This initiative is being spear-headed by the four regions of the American Association of State Highway and Transportation Officials (AASHTO), through a cooperative effort initiated by the Federal Highway Administration, with state transportation officials, and trucking industry leaders. The purpose of this paper is to outline the advantages to state and industry of uniform oversize and overweight permitting.

The recent focus on uniformity was encouraged by several trends taking place over the last few years. Rapidly rising fuel costs, the scarcity of qualified drivers, and fierce domestic and international competition had prompted trucking companies to turn to state and federal governments for help in clarifying and standardizing oversize and overweight permitting procedures. As a result, trucking industry leaders, and state and federal officials who have reviewed the issue of regulatory diversity, believe that the development of a simpler, uniform system for issu-

ing permits for routine oversize/overweight truck loads will reduce economic "trade barriers" between states. They believe that standardizing oversize and overweight permit requirements will, in effect, ease these trade barriers between states because it will reduce the cost of doing business for shippers and carriers. If the cost of doing business is reduced because a carrier or shipper's time is saved through more efficient multi-state permitting, the result will be increased economic growth for the industry, for the region, and for the country as a whole.

The purpose of this paper is to outline the advantages to state and industry of uniform oversize and overweight permitting.

Over the years, states have developed highly individualized rules and regulations concerning permitting, safety standards, and operating proce-

dures. In many cases these regulations stem from the requirements of regional geography, weather, population, or highway construction considerations. In other cases they have developed over time in the absence of incentives for coordination. This means that in order for regional uniformity to develop, a negotiation process should take place in which state and industry leaders believe that uniformity is to everyone's advantage.

If the cost of doing business is reduced because a carrier or shipper's time is saved through more efficient multi-state permitting, the result will be increased economic growth for the industry, for the region, and for the country as a whole.

Advantages for states are:

1. In a time when state resources are stretched thin, streamlining the process of truck permitting means that state transportation officials and engineers can spend more time on issues of safety and revenue generation.
2. Uniform permitting provides state transportation officials with the opportunity and rationale to more realistically estimate the actual cost of permitting. By working with other states, state officials are in position to quantify and allocate the real costs associated with truck travel and permitting to states. Information and experience gained in this effort provides a broader basis for each state to determine the most reasonable fees to charge for issuing permits. The cost of obtaining a permit should reflect not only the administrative expense for issuance, it should also provide for a reasonable and equitable allocation of cost to reflect highway capital and maintenance expenses.

3. More efficient processing of routine permits can lead to reduced incidences of operators not applying for a trip permit. This happens because of significant administrative complexities that can exist due to non-uniform, individualized state permitting requirements. If the time required to legally permit a vehicle is excessive, the incentive to operate without a permit, and risk being caught and paying a fine, is greater than the the incentive to legally permit a vehicle.
4. Experience has shown that a number of states have been able to upgrade their computer capabilities when senior managers realized the benefits to the agency of using more efficient computer technology to issue permits. This has led to an expanded use of computer technology for other departmental priorities.
5. Depending on the type of process that states develop, it is possible that the cost to states to issue permits can be reduced, even when individual state fee structures are unchanged. States which issue permits using the "Issuing State" process can issue permits on behalf of member states, without each state reviewing the permit application first.

Uniform permitting provides state transportation officials with the opportunity and rationale to more realistically estimate the actual cost of permitting.

6. State transportation officials will have the opportunity to advance their knowledge of state regulatory operations by taking advantage of the experience and practices of other states.

Advantages to industry are:

1. A more efficient multi-state permitting process will reduce a barrier to trade between states, thereby reducing the cost of doing business. Reduced inter-state trade barriers can occur in two ways:
 - as states achieve uniformity, safety and operating requirements will become standardized. This means that signs, flags, escort requirements and operating restrictions can be planned for in advance, allowing a carrier to operate with greatly increased efficiency.
 - a more efficient multi-state permitting operation is expected to save carriers a significant amount of time in applying for permits. This translates into direct cost savings for both shippers and carriers.
2. Multi-state uniform oversize and overweight truck permitting will level the playing field within the industry. If all states are part of a uniform permitting system, individual carriers will have less incentive and less opportunity to avoid permitting.
3. Shippers and carriers will be able to focus on more efficient multi-state logistics and routing due to the uniform permitting process.

Experience has shown that when states work together to address issues of common concern, individual state actions tend to be more efficient and

cost effective. Consequently, the mechanism established for developing uniform procedures for oversize and overweight permits will also be invaluable to states in dealing with other issues related to individual state transportation regulatory procedures.

Experience has shown that when states work together to address issues of common concern, individual state actions tend to be more efficient and cost effective.

To date, two uniform permitting systems have been developed and have been operating to the satisfaction of member states and regional industries in two different AASHTO regions. The AASHTO regions within which these uniform permitting systems are in place have undertaken to explore expanding these systems to the region as a whole. In addition, a third AASHTO region is about to implement a test phase of a regional permitting system, and a fourth region is also about to commit to developing an oversize and overweight uniform permitting system.

This summary of advantages is based on the actual experience of the states which have developed uniform permitting. As a national system grows, federal and state transportation officials and industry leaders believe that the benefits of uniform permitting will continue to become more apparent and achievable.

HIGHWAY SUBCOMMITTEE ON MAINTENANCE

of the Standing Committee on Highways

Removing Lead-Based Paint in Michigan

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Prior to 1975, it was common practice to coat the structural steel in bridges with lead-based paints. But because concerns for the effects of lead on human health and the environment have heightened, the use of lead-based paints has been significantly reduced throughout the country. During the 1970's, the United States government took steps to ban the sale of leaded paint for residential use and addressed the need for safe methods of removing leaded paint from old walls. The Food and Drug Administration encouraged the food industry to discontinue the use of lead solder on food cans, and the Environmental Protection Agency (EPA) initiated a phase-out of leaded gasolines for vehicles. However, a problem of considerable magnitude arose concerning the safe removal of lead-based paint from bridges during blast cleaning and painting work. This problem still presents complex social, environmental, and economic dilemmas.

Much of the burden of removing lead-based paint falls to state departments of transportation, some of which have brought their maintenance repainting programs to a halt in search of safe but economical methods for removing lead-based paint. This article describes the problems associated with lead paint removal, the way the Michigan Department of

Transportation (MDOT) has approached the problem, and the various containment measures that MDOT now employs to safely maintain its bridges.

The Problems

Proper mitigation of the problems associated with removing lead-based paints from bridges starts with an understanding of the threats to human health and the environment. The first point to realize is that even in very small quantities, lead is toxic when ingested or inhaled. The toxicity is especially pronounced in young children because lead hinders the proper development of the central nervous system. Therefore, in blast cleaning bridges, the toxic effects of lead must be considered for two groups: the general public in the vicinity of the bridge, and the workers performing the blast cleaning.

Threats to human health and to the environment are closely related. In terms of direct effects on the environment, lead-based paint residues are not considered to be significantly polluting or unsafe. Most lead-based paints used on bridges contain a very stable lead compound that does not easily break down or introduce free lead into the soil or water. The Transportation Research Board's Report,

Removal of Lead-Based Bridge Paints (1983), states that all existing research indicates that the lead is securely bound up in clay soil particles in the ground or on a river or lake bottom, and poses no immediate environmental threat. Lead is not normally picked up by vegetation or animals and introduced into the food chain. Instead, the main problem associated with lead paint removal involves avoiding contamination of places such as recreational or private residential properties, where people might ingest or inhale the material.

Air pollution caused by blast cleaning is a temporary condition, and its seriousness depends on potential exposure of the general public to lead-contaminated dust, or dust from other toxic pigments contained in paints, such as chromium. Because air pollution resulting from blast cleaning is a temporary condition, the workers can be adequately protected by use of air-supplied hoods, and people in vehicles traveling through a work area are not exposed to the dust long enough to be considered in any danger.

Yet another aspect of the problems associated with removing lead paint from bridges involves the distinction between total lead content and leachable lead content, and the distinction between hazardous and non-hazardous waste. The waste generated during the blast cleaning of a bridge contains the original abrasive used, paint chips and dust from the bridge, and all other debris removed from the steel members. Handling and disposing of this spent material does not depend on the total lead content but on the "leachable lead content." Leachable lead content refers to the percentage of lead that can be extracted from a sample of spent material using a standardized acid leach test known as the EP (extraction procedure) toxicity test. This test, developed by the EPA, is a national standard test that measures the potential for lead and other heavy metals to leach from a waste and enter the ground water. The required acidic pH of the test is considered to be the most severe condition that the waste may be exposed to in a typical sanitary landfill.

Under current EPA rules, if the leachable lead exceeds five parts per million (ppm), then the waste

is designated as a "hazardous waste" and as such must be disposed of in a special hazardous waste disposal facility. If the leachable lead is less than 5 ppm, the waste is designated as nonhazardous and may be disposed of at a regular, licensed sanitary landfill, regardless of total lead content.

It is important to note here that blast cleaning a particular bridge may generate a spent material judged non-hazardous by the EP toxicity test, even though it may have a total lead content as high as 4,000 ppm (or higher). Hence, the material still poses a potential health threat to humans if ingested or inhaled. Once the material is properly placed in a sanitary landfill, however, the potential for human toxicity is removed. As used in the EP toxicity test, the terms "hazardous" and "non-hazardous" are somewhat misleading: they refer to potential hazard to the environment caused by leaching into the ground water, not to hazards associated with direct human contact.

Michigan's Approach to Removing Lead-Based Paint

Resolving the problems of removing lead-based paint from bridges involves meeting and reaching agreements with all relevant state agencies. Michigan did this in the fall of 1986 by establishing a Task Force on Removal of Lead-Based Paints on Bridges. The Task Force was comprised of high level representatives from the departments of Transportation, Natural Resources, and Public Health. Representation of the Department of Transportation included the Construction, Maintenance, and Materials and Technology divisions. The Public Health Department had representation from the divisions of Human Toxicology and Occupational Health. The Department of Natural Resources had representation from the divisions of Water Quality, Air Quality, Fisheries and Wildlife, and Hazardous Waste.

Since the proper agency representative for each aspect of the problem was involved, no solutions were derived that overlooked important points. Once all representatives had a general understanding of

the problems and economic constraints, the Task Force adopted a philosophy of seeking and using the Best Available Control Technology (BACT). This philosophy was essential to achieving practical solutions and reasonable costs to allow the continuation of critical bridge painting while adequately protecting human health and the environment.

Determining Degrees of Hazard

The first and perhaps most important agreement reached by the Task Force was that not all bridges in the highway system pose the same degree of hazard to human health or the environment. Therefore, the degree of containment required to protect the public and environment could vary. For example, for a bridge adjacent to residential or recreational property, control measures aimed at total containment to prevent lead-contaminated dust from entering adjacent areas would be justified. But for a bridge in a rural setting, adjacent only to the highway right-of-way, total containment measures would not be justified. Thus, the Task Force developed a control system for classifying each bridge into one of three categories, according to the proximity of the structure and work area to occupied private property. The categories are listed below.

- **Class 1:** A highway or railway grade crossing bridge with the right-of-way completely enclosing the work area and no occupied private properties adjacent to the bridge
- **Class 2:** A highway or railway bridge crossing a waterway with the right-of-way and waterway completely enclosing the work area and with no occupied private properties adjacent to the bridge
- **Class 3:** A highway or railway bridge with residential, recreational, or other occupied properties in close proximity to the work area, where people (in addition to the workers) may be exposed to the blast cleaning environment

Based on this system, the Task Force developed

specifications for various degrees of containment during blast cleaning. These specifications, in turn, were to be clearly stated on the contract plans so that the contractor would know exactly what to bid on for blasting controls. The various containment measures required are discussed below by class.

Containment Measures for Class 1 Bridges

Fortunately, the majority of bridges on a typical Michigan highway fall into the Class 1 category. Even though a degree of judgment must be applied, in general, if a bridge is located in excess of 200 feet from an occupied private property, the majority of the blasting dust can be contained with minimal effort. For Class 1 bridges, all areas underneath the immediate work area must be covered with ground tarps to collect the spent materials falling from the bridge. The limits of tarping are 20 feet beyond the edges of the bridge.

This control is very effective in collecting the majority of the spent material generated. Even though some material falls outside the 20-foot limits, it poses no immediate threat to human health or the environment for a Class 1 bridge. Hence, economic considerations dictate the more moderate containment measures.

If a private residence or facility is located fairly close to the bridge but beyond 200 feet, an additional requirement calls for tarping along one or two sides of the work area to contain the dust. The tarpaulins must be made of an airtight material and must be tightly secured at the seams and ground. Burlap or open web materials do not work and, therefore, are not allowed. Moreover, the engineer has the authority to temporarily suspend the blasting operations when adverse winds create a problem with containment. These specifications have been working very well for Class 1 bridges.

Disposal of spent material for Class 1, Class 2, and Class 3 bridges includes several procedures. The work area and ground tarps are required to be cleaned up every day, and all spent materials are stored in waterproof containers such as barrels or covered gondolas.

No waste disposal is allowed until the spent materials are sampled and tested by the MDOT. MDOT conducts all EP toxicity testing to avoid the situation of a contractor generating erroneous test results. Were the contractor to do so, MDOT could risk large liability losses since it, not the contractor, is considered the generator of the waste. (Therefore, granting the contractor economic incentive to produce non-hazardous waste should be viewed as a risky approach.)

Each structure is tested independently using a composite sample of the waste piles generated. Approximately 40 percent of all bridges blast cleaned have resulted in hazardous waste, with the leachable lead ranging from 5.1 ppm to 25 ppm.

A delay in the disposal of hazardous waste can result from the EPA's issuing of a required generator number. Because the issuing process can take over six weeks from the time of application, the project engineer will normally apply for a number before beginning the work. Then, if the spent materials are non-hazardous, the number is reported back as inactive.

If the EP toxicity test shows leachable lead below the 5 ppm maximum limit, the contractor disposes of the spent material in a licensed sanitary landfill. Disposal of non-hazardous material is considered an incidental cost to blast cleaning the structure. But if the toxicity test shows leachable lead above the 5 ppm limit, the material is disposed of at a licensed hazardous waste facility. (There is one such facility in Michigan, located in Wayne County.) Transport of hazardous waste must be done by properly licensed haulers. The contractor is not allowed to move the materials from the storage containers. No particular problems have resulted from the testing, handling, and disposal process.

All costs associated with hazardous waste handling and disposal are paid for on a force account basis, thus eliminating the need for the contractor to bid on an uncertain work item. The hazardous waste disposal cost has been reasonable, running between \$200 and \$300 per cubic yard for transportation and disposal.

Containment Measures for Class 2 Bridges

The only difference between a Class 1 bridge and a Class 2 bridge is the occurrence of a waterway under the Class 2 bridge. Michigan is covered with a vast network of streams, rivers, and lakes, so maintaining high water quality is a top priority. The depositing of blasting debris on a stream bottom results in the creation of silt, which adversely affects the spawning of certain species of fish.

Given the need to maintain high water quality, all containment specifications for Class 1 apply to Class 2, but Class 2 bridges require additional measures to protect the waterways. The contractor must place a barge in the waterway below the work area and extend tarps down to the barge to collect the blasting materials. If the stream is too shallow for a barge, the contractor must erect some type of temporary work platform or tarpaulin arrangement to collect the spent material or to direct it to the banks for collection. The spent materials are picked up daily and stored in covered containers. These requirements have proven very effective for keeping spent materials out of the water, having at least an 80 percent rate of retrieval.

In addition to the barge, a floating boom or skimmer must be stretched across the waterway within 200 feet of the work area. The boom or skimmer contains all dust deposits that fall from the work area and form a scum on the water surface. The scum is not an immediate threat to public health, but if it is not contained, it will lead to numerous complaints from swimmers, fishermen, and boaters.

Containment Measures for Class 3 Bridges

A bridge is designated as Class 3 whenever there is a significant risk that the general public could be exposed to the lead-contaminated dust or debris generated by the blast cleaning. The intent of the Class 3 specification is to provide total containment of all spent materials. It has been MDOT's experience that total containment is possible, but it adds approximately 50 percent to the cost of blast cleaning. Current contract painting in Michigan is run-

ning approximately \$2 per sq ft on Class 1 and Class 2 bridges for blast cleaning to a near-white condition (SSPC SP-10), and \$3 per sq ft for Class 3 bridges.

Used sparingly, the Class 3 designation is usually assigned when a bridge is adjacent to occupied properties within the 200-foot limit. A Class 3 bridge over a waterway is simultaneously designated as Class 2 to invoke the barge and skimmer requirements.

The specification for Class 3 blast cleaning includes a two-step procedure: wet abrasive blasting followed by dry blasting. All blasting is done inside a tightly enclosed work area. The wet abrasive blast is required to remove the lead paint inside the enclosure, without exceeding the safe limits of lead in the air for the workers. Even when air-supplied hoods are worn, the occupational safety limit for lead in the air is 200 micrograms per cubic meter, averaged over an eight-hour period.

The use of a simple water ring around the blasting nozzle is very effective in eliminating dust within the enclosure and protecting the health of the workers. No rust inhibitors are allowed in the water since they may have an adverse effect on the applied coating.

A three-day minimum drying time is required for Class 3 bridges, followed by a dry blast to a near-white condition before painting. The dry blast is also done within the enclosure, but because all lead has already been removed, the lead hazard to the workers has been eliminated.

The spent material from the wet abrasive blasting must be checked by the EP toxicity test since the material contains the removed lead-based paint. The spent material from the dry blasting does not need to be tested. All approved abrasives used on Michigan work are pre-screened for the presence of heavy metals or other contaminants that may contribute to hazardous waste or toxicity. Before being approved, they must also pass an evaluation to be classified as low dusting abrasives.

Alternate Methods for Total Containment

Alternate methods for blasting with total containment can be proposed by the contractor for consideration. Such alternate methods are approved only if no blasting dust or debris can escape the right-of-way area and if provisions are made to protect worker safety. To date, two alternate methods have been successfully used.

The first alternate method was the use of an enclosure with a negative pressure induced by a large vacuum pump. A one-step dry blasting was allowed because evacuation of the enclosure was sufficient to keep the air practically clear of dust. Hence, the workers were adequately protected in air-supplied hoods. The dust evacuated from the enclosure was filtered out by a conventional bag house filtration system. This method appears to have been effective, but the equipment required is costly and not readily available to most painting contractors.

The second alternate method was a variation on the use of an enclosure with an induced negative pressure. The contractor also used a one-step dry blast, with steel shot for the abrasive. The steel shot and paint chips were collected through a funnel-type enclosure. The shot was then separated by passing the residue through a cyclone separator. The heavy steel shot fell downward while the dust was sucked out the sides by a 360-degree vacuum air flow. The dust drawn off by the vacuum pump was separated in a water scrubber rather than through air filters.

The second alternate method has great potential because the volume of spent material was reduced to a minimum and was comprised of the paint removed as well as any dirt or debris on the steel. The steel shot had little breakdown, and, by being recycled, it did not enter the waste pile. The total lead content in the waste dust collected was so high (approximately 30,000 ppm) that it may have industrial value for reclaiming the lead compounds contained. (If it does have such value, the present dilemma of disposing of hazardous waste would certainly be revolutionized.)

Conclusion

To date, MDOT has contracted over 100 bridges for blast cleaning and painting with the system described. Through close monitoring and inspection by field crews, the success rate has been outstanding. MDOT has experienced no significant complaints or violations of environmental controls. Close contact among the departments of Transportation, Natural Resources, and Public Health has been maintained to address problem areas and to consider new developments.

The coating system now used on all Michigan bridges is a three-coat system comprised of an organic zinc-rich primer, a polyamide epoxy interme-

diate coat, and an aliphatic polyurethane topcoat. This coating system contains no heavy metals currently classified as hazardous waste. Current contract prices for paint application are averaging approximately \$1/sq ft for the field application of the three-coat system.

Although the current system for blast containment is working well, MDOT remains committed to considering new equipment and methods for improving its approach to the problems associated with lead paint removal. MDOT's agreement with other agencies in mitigating these problems requires the continued implementation of the Best Available Control Technology.

HIGHWAY SUBCOMMITTEE ON MATERIALS

of the Standing Committee on Highways

A Draft Report on WASHTO Modal Quality Assurance Specifications

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At the 1988 Joint WASHTO Construction/Materials committee meeting in Kalispell, Montana a decision was made to develop a model set of quality assurance specifications that would be applicable to the member states. A Task Force was organized which consisted of representatives from eight of the states, four from the Construction group and four from the Materials group. These same states indicated a willingness to support a pooled fund effort to accomplish this task.

FHWA endorsed the proposed study and a memorandum of support was signed by the Regional Administrators of Regions 6, 8, and 10 on October 11, 1988 for a regional pooled fund study. The regional pooled fund was set up and the first meeting of the Task Force was held on July 18, 1989 in Billings, Montana.

Project Objectives

The objectives of the Task Force were to collect, analyze, and summarize current applications of Quality Assurance programs and specifications in use and proposed by WASHTO States and other selected States and develop a model set of quality assurance specification that would be appropriate

for implementation and use by WASHTO States.

Task Force Statement

The task force firmly believes that the Agencies who choose to use Quality Assurance (QA) specifications will benefit in some or all of the following ways:

1. The use of QA Specifications will result in a transfer of the responsibility for quality control to the Contractor.
2. The move toward QA specifications will assure acceptable quality in our present state of diminishing resources in both manpower and money.
3. The money paid out in incentives is more than offset by a more consistent product, a reduction in nonspecification work, and reduced manpower needs.
4. The use of QA specifications will result in an overall improvement in quality.

5. The Agency will be able to plan and more efficiently use its limited available manpower.
6. The use of QA specification will result in less contractor claims.
7. Agency testing costs will be minimized due to the possible elimination of field test labs and reduction of test personnel.
8. The WASHTO States that have used QA specifications and have realized some or all of these benefits include Arizona, Colorado, Montana, Utah, Wyoming, Washington, Oregon, Oklahoma, and Texas.

Implementation

Implementation of Quality Assurance Specifications is a major change in the way that State Highway Agencies have historically operated. As with any change there may be resistance both within and outside the organization. The Quality Assurance Specifications provided herewith are intended as a guide for State Highway Agencies to follow in developing their own specifications. Modification will be required to fit the individual agencies' needs, conditions, and performance history. Modifications should be done with care to avoid inconsistent and conflicting requirements. Also, caution must be exercised so that current method type specifications are not mixed with Quality Assurance Specifications which would compromise the effectiveness of either program. Changes in one part may require changes in others. It is important that representatives of the construction industry are involved in the development of Quality Assurance Specifications. The construction industry will be able to adjust to the conceptual change if the Quality Assurance Specifications are reviewed, discussed, and in some cases, adjusted prior to implementation.

A State Highway Agency should utilize a transition period in order to implement Quality Assurance Specifications. The use of Quality Assurance Specifications necessitates that contractors/suppliers develop a Process Quality Control Program to

monitor, evaluate, and control the work product(s). The development of Process Quality Control Programs should be initiated prior to the issuance and use of Quality Assurance Specifications by the Agency. The use of trial projects to evaluate and modify the specifications should prove to be beneficial to the agency in obtaining acceptance of change. In developing and letting trial projects the State Highway Agency may choose to have pre-bid conferences and require that prospective bidders attend such conferences. The use of pre-bid conferences allows the State Highway Agency to clearly state to the prospective bidders the intent of the specifications and the need to have a Process Quality Control Program. Other issues such as technician qualification, accreditation of testing laboratories, and incentives-disincentives may be discussed and fully outlined at this pre-bid meeting.

The State Highway Agency must exercise caution in the use of historical data in the development and implementation of Quality Assurance Specifications. Test result information from method specifications by nature will be biased. The State Highway Agency should consider utilizing the recommended acceptance criteria and the pay factor table included within these model Quality Assurance Specifications. The State Highway Agency will then be able to develop a data base which can be evaluated to ensure that the specification limits are appropriate.

Training is the single most important issue which an agency will address during implementation. It is imperative that appropriate training seminars are developed and utilized to assure that the Quality Assurance Specifications are understood and appropriately applied by the agency's personnel. Any specification requirements which require contractor technician qualifications will necessitate that agency technicians are similarly qualified. Training should be developed to address the qualification requirements. The Agency should work in cooperation with industry representatives to assure that the technicians responsible for the contractor's Process Quality Control receive the necessary training to assure quality work.

A Quality assurance program must also be maintained by the Agency which chooses to use QA specifications. This program should include elements such as calibration of testing equipment, test methods, independent assurance testing and witnessing, correlation testing, and certification of testing personnel.

Again, the importance of industry involvement in development and implementation is strongly emphasized to assure a successful program.

Evaluation and Feedback

Permanent records should be maintained on the results of all acceptance testing. This data should be statistically analyzed annually to guarantee that upper and lower specification limits are appropriate. Desirable specification limits minimize both the "buyer's risk" and the "seller's risk" while still assuring acceptable performance. Pay factors should be reviewed to assure that "incentive-disincentive" amounts are fair and equitable to all parties involved. The analysis of test data must be accomplished by a person who is not only a qualified statistician but is also knowledgeable in highway construction practice.

Statistical data gathered during acceptance testing provides not only a means of acceptance of and payment for materials produced, but also provides a data base of "as constructed" information that can be utilized in management information systems such as pavement management, maintenance management, and highway performance monitoring systems as well as for failure analysis in the event of premature failure. The information also provides a readily available means of evaluating the production capabilities and relative performance levels of contractors.

By continually monitoring the quality of the contractor's work through acceptance testing and statistically analyzing the results of these tests on an annual basis, specification limits and pay factors can be maintained which will assure that quality work is produced and that payment made for ac-

ceptable work within specified limits is fair and equitable.

Section 106— Control of Materials

106.03 Inspection and Testing of Materials

- (a) *General.* All materials are subject to inspection, sampling, and testing at any time before acceptance of the work.

A reference in the contract to a (Insert Agency) Test Method, a Federal specification, a specification or test designation of the American Association of State Highway and Transportation Officials (AASHTO), the American Society for Testing and Materials (ASTM), or any other recognized national organization, shall mean the latest revision of the specification or test designation in effect on the day the advertisement for bids for the work is dated unless otherwise designated.

Materials will be sampled and tested by a representative of the Agency unless otherwise specified in the special provisions. Copies of all test results will be furnished to the Contractor's representative at the Contractor's request. The Contractor shall not rely on results of Agency testing being available for Process Quality Control.

The Contractor may observe the Agency's sampling and testing. If a deviation from the specified sampling or testing procedures is observed, the Contractor shall describe the deviation to the Engineer's designated representative immediately and document the deviation in writing within 24 hours.

- (b) *Acceptance Sampling and Testing.* Items designated for acceptance under Quality Assurance (QA) provisions will be randomly sampled and tested in accordance with the recommended acceptance guidelines. Samples may also be taken any time the material appears defective or when the Engi-

neer determines that a change in the process or product has occurred.

Acceptance tests will govern in all cases for determination of pay factors without regard to quality control tests.

106.04 Contractor Process Quality Control.

The Contractor shall provide process control adequate to produce work of acceptable quality. The Contractor shall perform process control sampling, testing, and inspection during all phases of the work at a rate sufficient to assure that the work conforms to the contract requirements.

The Engineer will not sample or test for process quality control or assist in controlling the Contractor's production operations. The Contractor shall provide personnel and testing equipment capable of providing a product which conforms to specified requirements. Continual production of nonconforming work at a reduced price, in lieu of adjustments to bring work into conformance, is not allowable.

Note: The following is a guide for use by individual Agencies who wish to require Contractor process quality control system.

- (a) *Contractor Process Quality Control Plan.* The Contractor shall provide and maintain a Process Quality Control Plan, hereinafter referred to as the "Plan", including all the personnel, equipment, supplies, and facilities necessary to obtain samples, perform tests, and otherwise control the quality of the product to meet specified requirements.

The Contractor shall be prepared to present and discuss, at the pre-construction conference, quality control responsibilities for specific items as included in the contract. The Contractor shall submit the Plan for the appropriate items to the Engineer for approval a minimum of ten working days prior to the start of related work. The Contractor shall not start work on the sub-

ject items without an approved Plan. Partial payment will not be made for materials subject to specific quality control requirements without an approved Plan. The approval process for the Contractor's Plan may include inspection of testing equipment and a sampling and testing demonstration by the Contractor's technician(s) to assure an acceptable level of performance.

The Contractor shall certify in writing to the Engineer that the testing equipment to be used is properly calibrated.

- (b) *Quality Control Laboratory.* All Contractor process quality control testing under the Plan shall be performed by qualified technicians in laboratories meeting Agency requirements.

Laboratory facilities shall be kept clean and all equipment shall be maintained in proper working condition. The Engineer shall be permitted unrestricted access to inspect and review the Contractor's laboratory facility. The Engineer will advise the Contractor in writing of any noted deficiencies concerning the laboratory facility, equipment, supplies, or testing personnel and procedures. Deficiencies shall be grounds for the Engineer to order an immediate stop to incorporating materials into the work until deficiencies are corrected.

Note: Each Agency should establish requirements for testing laboratories based on their needs and the facilities available. See Appendix A for an example.

- (c) *Plan Administration and Technician Qualifications.* The Plan shall be administered by a qualified individual.

The individual administering the Plan must be a full-time employee of or a consultant engaged by the Contractor. The individual shall have full authority to institute any and all actions necessary for the

successful operation of the Plan. This individual may supervise the Plan on more than one project if the job site is within one hour of the other projects.

Process Control Technicians (PCT) and Quality Control Technicians (QCT) performing the actual sampling, testing, and inspection shall be qualified.

Note: Each Agency may set minimum qualifications for the Plan Administrator and for technicians. See example in Appendix B and C.

- (d) *Sampling.* The Plan shall contain a system for sampling that assures all material being produced has an equal chance of being selected for testing. The Engineer shall be provided the opportunity to witness all sampling.

When directed by the Engineer, the Contractor shall sample and test any material which appears inconsistent with similar material being sampled, unless such material is voluntarily removed and replaced or corrected by the Contractor. All sampling shall be in accordance with Agency, AASHTO, or ASTM procedures.

- (e) *Testing.* All testing shall be performed in accordance with the acceptance test procedures applicable to the specified contract items or other methods set forth in the approved Plan. Should acceptance test procedures not be applicable to quality control tests, the Plan shall stipulate the test procedures to be utilized. The Contractor shall provide copies of all test results upon request on forms meeting the approval of the Engineer.
- (f) *Records.* The Contractor shall maintain complete records of all process quality control tests and inspections. The records shall be available to the Engineer for review and copies furnished upon request.

Control Charts acceptable to the Engineer shall be maintained and kept current at a location satisfactory to the Engineer. As a minimum, the Control Charts shall identify the project number, the contract item number, the test number, each test parameter, the upper and lower specification limit applicable to each test parameter and the Contractor's test results. The Contractor shall use the Control Charts as part of a process control system for identifying production and equipment problems and for identifying pay factor reductions before they occur.

- (g) *Payment.* When a contract pay item for Contractor Process Quality Control is provided, the Contractor will be paid the contract lump sum amount bid according to the following partial payment schedule.

1. Twenty-five percent of the contract lump sum bid amount or one-half percent of the original contract amount, whichever is less, when the quality control plan is approved.
2. The remaining portion of the contract lump sum bid amount will be paid on a prorated basis according to total job progress.

Payment will be full compensation for providing and maintaining the approved quality control plan and performing all sampling, testing, and inspections in conformance with requirements of the contract. Failure of the Contractor to provide properly documented test results in a timely manner will be justification for withholding progress payments or portions thereof.

106.05 Evaluation of Materials for Acceptance.

Material specified to be sampled and tested on a Quality Assurance (QA) basis will be evaluated for acceptance in accordance with this Subsection. All acceptance test results for a lot will be analyzed collectively and statistically by the Quality Level

Analysis—Standard Deviation (Specification Conformance Analysis) Method using the procedures listed to determine the total estimated percent of the lot that is within specification limits. Quality Level Analysis (Specification Conformance Analysis) is a statistical procedure for estimating the percent compliance to a specification and is affected by shifts in the arithmetic mean (\bar{X}) and by the sample standard deviation (s). Analysis of test results will be based on a Quality Level (QL) of 95.0 and a contractor's risk of 0.05, unless otherwise specified. QL may be viewed as the lowest percent within the specification limits of a material that is acceptable as a process average and receive 100 percent pay. The contractor's risk is the probability that when the Contractor is producing material at exactly the QL, the materials will receive less than a 1.00 pay factor.

Note: At the individual Agency's preference, the pay factor used for adjustment of contract unit prices may be either: (1) the lowest pay factor of all of the indicated properties, or (2) a composite pay factor. The assigned weights and/or incentive payments for the various properties must be determined by the individual Agency according to what they consider to be the most important material properties with regard to benefits expected, such as durability, strength, pavement life, etc. The model specifications only address the composite pay factor method. It was felt that the lowest pay factor method decreases the Contractors' incentive to produce a better quality product.

As an incentive to produce a quality material, a pay factor greater than 1.00 may be obtained. The maximum pay factor obtainable is 1.05.

Note: The above paragraph should be deleted by Agencies where statute or regulation prohibits incentive payment.

A lot containing non-specification material (less than 1.00 pay factor) may be accepted provided the pay factor is at least 0.75 and there are no isolated defects identified by the Engineer. A lot may be terminated by the Engineer and the material in the shortened lot paid for at a reduced pay factor or the

Engineer may order the non-specification material removed.

A lot containing non-specification material that fails to obtain at least a 0.75 pay factor will be rejected. The Contractor may submit a written request for acceptance of the material at a reduced price or approved correction. Such request shall include an engineering analysis showing expected effects on performance. The Engineer will determine whether or not the material may remain in place at the price reduction.

Note: Any lot for which at least three samples have been obtained and which meets the following criteria will receive at least a 1.00 pay factor if:

- All test results are within the allowable deviations specified for the item, and
- All test results are greater than or equal to a minimum specification limit, or
- All test results are less than or equal to a maximum specification limit, whichever is appropriate.

This is a practical modification which may slightly reduce the Contractor's risk.

Computation of the Quality Level in these instances will determine the amount of any quality incentive.

Note: The above paragraph should be modified if quality incentive payments are not allowed.

If less than three samples have been obtained at the time a lot is terminated, the material in the shortened lot will be included as a part of an adjacent lot at the pay factor computed for that revised lot.

The Engineer may reject material which appears to be defective based on visual inspection. Such rejected material shall not be used in the work.

No payment will be made for the materials rejected by the Engineer unless the Contractor re-

quests the material be tested. If so requested prior to disposal, three representative samples will be obtained and tested. The tests results will be statistically evaluated. If found to have a pay factor of less than 0.75 or otherwise specified, no payment will be made and the Contractor will bear the cost of the sampling, testing, and evaluation. If the pay factor is 0.75 or as otherwise specified and greater, payment will be made for the materials at the invoice cost plus ____ percent (10 percent suggested).

(a) *Quality Level Analysis.* Standard deviation method procedures are as follow:

1. Test results on material not incorporated in the work will not be included in the quality level analysis.

2. Determine the arithmetic mean (\bar{X}) of the test results:

$$\bar{X} = \frac{\sum x}{n}$$

Where: Σ = summation of

x = individual test values x^n

n = total number of test values

3. Compute the sample standard deviation(s):

$$s = \sqrt{\frac{n \sum (x^2) - (\sum x)^2}{n(n-1)}}$$

Where: Σx^2 = summation of the squares of individual test values.

$(\Sigma x)^2$ = summation of the individual test values squares.

4. Compute the upper quality index (Q_u):

$$Q_u = \frac{USL - \bar{X}}{s}$$

Where: USL = upper specification limit or target value (TV) plus allowable deviation.

Target Value = the single specification value which would result in an ideal product as defined by the Agency.

5. Compute the lower quality index (Q_L):

$$Q_L = \frac{\bar{X} - LSL}{s}$$

Where: LSL = lower specification limit or target value minus allowable deviation.

6. Determine P_u (percent within the upper specification limit which corresponds to a given Q_u).

Note: If a USL is not specified, P_u will be 100.

7. Determine P_L (percent within the lower specification limit which corresponds to a given Q_L).

Note: If an LSL is not specified, P_L will be 100.

8. Determine the Quality Level (the total percent within specification limits).

$$\text{Quality Level} = (P_u + P_L) - 100$$

9. Using the Quality Level from step 8, determine the lot pay factor (PF).

10. Determine the Composite Pay Factor (CPF) for each lot.

$$CPF = \frac{[f_1(PF_1) + f_2(PF_2) + \dots + f_j(PF_j)]}{\sum f = 1 \text{ to } j}$$

Where: f_j = price adjustment factor listed in the specifications for the applicable property.

PF_j = Pay Factor for the applicable property.

Σf = Sum of the "F" (price adjustment) factors.

Note: Numbers used in the above calculations shall be carried to significant figures and rounded according to AASHTO Standard Recommended Practice R-11.

Section 203—Excavation and Embankment

203.01 Description. This work consists of excavation, hauling, disposal, placement, and compaction of all materials necessary for the construction of the roadway.

203.02 Construction Requirements

(a) Contractor Process Quality Control.

1. General Requirements. The Contractor shall administer a Process Quality Control Plan sufficient to assure a product meeting the contract requirements. The Plan shall meet the requirements of Subsection 106.04.
2. Elements of the Plan. The Plan shall address all elements which affect the quality of the earthwork including, but not limited to the following:
 - a) Moisture
 - b) Compaction
 - c) Construction of embankments
 - d) Conformance to plan profile and cross-section.
3. Personnel Requirements. The Plan shall include the following technician(s):

Quality Control Technician(s) (QCT) shall utilize test results and other quality control practices to assure that embankments meet the contract requirements. The Plan shall detail the frequency of

sampling and testing, corrective actions to be taken, and documentation.

The QCT shall periodically inspect all equipment utilized in the placement, compaction and finishing of embankments to assure it is operating properly and that all earthwork conforms with the contract requirements. The Plan shall detail how these duties and responsibilities are to be accomplished and documented, and whether more than one QCT is required. The Plan shall include the criteria utilized by the QCT to correct or reject unsatisfactory earthwork.

- (b) *Other Requirements.* Refer to Agency requirements.

203.03 Acceptance. Earthwork will be sampled on a statistically random basis, tested, and evaluated in accordance with Subsection 106.05(a), Quality Level Analysis, using steps 1 thru 7 only. Acceptance will be at an 85 percent quality level with all material below that level reworked. Evaluation of materials will be made using the following limits:

| Measured Characteristic | LSL | USL |
|-------------------------|-------------------------------|--------------|
| Moisture | Optimum-2% | Optimum + 2% |
| Density | 95% Max. Density (AASHTO T99) | None |
| Surface Tolerance | TV-.05 ft. | TV + .05 ft. |

Note: The $\pm 2\%$ target value (TV) for moisture is for fine grain soils only.

203.04 Method of Measurement. Refer to Agency methods.

203.05 Basis of Payment. Refer to Agency methods.

Section 304—Aggregate Base Course

304.01 Description. This work consists of constructing an aggregate base course on a prepared foundation.

304.02 Materials. Materials shall conform to the requirements specified in the following Subsections.

| | |
|------------------|--------|
| Aggregate | 703.06 |
| Water | 714.01 |
| Calcium Chloride | 714.02 |
| Sodium Chloride | 714.04 |

Note: Agencies may substitute their own materials requirements.

304.03 Construction Requirements

(a) Contractor Process Quality Control.

1. General Requirements. The Contractor shall administer a Process Quality Control Plan sufficient to assure a product meeting the contract requirements. The Plan shall meet the requirements of Subsection 106.04.

2. Elements of the Plan. The Plan shall address all elements which affect the quality of the aggregate bases including, but not limited to the following:

- a) Aggregate Production
- b) Quality of Components
- c) Stockpile Management
- d) Proportioning
- e) Mixing and Processing
- f) Transporting
- g) Placing and Spreading
- h) Compaction
- i) Finishing

3. Personnel Requirements. The Plan shall include the following technicians:

a) Process Control Technician(s) (PCT) shall utilize test results and other quality control practices to assure the quality of each aggregate material source utilized and adjust and control crushing and/or mixing proportioning to meet the specified material requirements. The Plan shall detail the frequency of sampling and testing, corrective actions to be taken, and documentation.

The PCT shall periodically inspect all equipment utilized in aggregate base production to assure it is operating properly and that all aggregate base produced meet the contract requirements. The Plan shall detail how these duties and responsibilities will be accomplished and documented. The Plan shall include the criteria utilized by the PCT to correct or reject unsatisfactory materials.

b) Quality Control Technician(s) (QCT) shall perform and utilize quality control tests at the job site to assure that the delivered materials meet the contract requirements. The QCT shall inspect all equipment utilized in mixing, processing, transporting, placing, spreading, compacting, and finishing to assure it is operating properly and that the installation of the aggregate materials conforms with the contract requirements. The Plan shall detail how these duties and responsibilities are to be accomplished and documented, and whether more than one QCT is required. The Plan shall include the criteria utilized by the QCT to correct or reject unsatisfactory materials.

c) The Plan shall detail the coordination of the activities of the PCT and QCT.

(b) *Other Requirements.* Refer to Agency requirements.

304.04 Acceptance. Aggregate base course will be sampled on a statistically random basis, tested, and evaluated in accordance with Subsection 106.05(a), Quality Level Analysis, using steps 1 through 7 only. Acceptance will be at an 85 percent quality level with all material below that level reworked. Evaluation of materials will be made using the following limits:

| Measured Characteristic | LSL | USL |
|-------------------------|-------------------------------|--------------------------|
| Gradation | TV-(Specified by Agency) | TV+(Specified by Agency) |
| Density | Minimum 95% AASHTO T180(D) | None |
| Surface Tolerance | TV - 0.05 ft. | TV + 0.05 ft. |

Note: Agencies should establish LSL and USL for the gradations of the various aggregate bases used.

304.05 Method of Measurement. Refer to Agency methods.

304.06 Basis of Payment. Refer to Agency methods.

Note: If pay is to be adjusted in accordance with 106.05, the Agency must establish the factors "F" for gradations of various aggregate bases used. See Subsection 401.06 for an example of the use of these factors.

Section 401—Asphalt Concrete Pavements

401.01 Description. This work consists of constructing one or more courses of asphalt concrete pavement on a prepared subgrade or base course.

401.02 Materials. Materials shall meet the requirements of the following Sections or Subsections:

| | |
|-------------------|--------|
| Portland Cement | 701.01 |
| Asphalt | 702.00 |
| Aggregate | 703.00 |
| Mineral Filler | 703.12 |
| Hydrated Lime | 714.03 |
| Fly Ash | 714.11 |
| Asphalt Additives | _____ |

Note: Agencies may substitute their own materials requirements.

(a) Composition of Mixtures.

Option 1, Contractor Provided Mix Design.

A job-mix formula shall be developed by the Contractor utilizing guidelines provided by the Agency. The job-mix formula shall be developed utilizing aggregate which has been crushed, processed, separated and stockpiled for the project. The mix design gradation shall be within the gradation ranges for the designated grading.

The mix design shall be prepared under the direct supervision of a professional engineer experienced in the development of mix designs and mix design testing.

The mix design shall contain as a minimum:

1. The name and address of the testing organization and the person responsible for the mix design testing.
2. The specific location(s) of the source(s) of aggregate.
3. The supplier, refinery, and type of asphalt, and the source and type of portland cement, mineral filler, hydrated lime, fly ash, and/or asphalt additive, and the percentages of each to be used.
4. The anticipated aggregate gradation in each stockpile.
5. Mix design gradation.
6. The results of all testing required by the Agency.

The mix design shall be submitted on a laboratory bituminous mixture design form in Agency format and signed by a person authorized to act on the Contractor's behalf.

The Engineer will review and approve or reject the mix design and notify the Contractor in writing within ____ days.

If the Contractor elects to change the source of material(s), or revise the mix design, the Engineer shall be furnished with a new mix design.

Option 2, Agency Provided Mix Design. It is the Contractor's responsibility to ensure that the produced material will provide an asphalt concrete mixture that conforms to the applicable Agency design parameters.

At least ____ days prior to the production of asphalt concrete the proposed job-mix formula shall be submitted to the Engineer for approval and shall include the following:

1. Aggregate samples representing each stockpile.
2. The proposed percentage of each stockpile to be used, the average gradation of each stockpile, and the proposed target value for each sieve size. The target values and the combined average gradation of all the stockpiles when combined in accordance with the Contractor's recommendation shall be within the gradation ranges for the designated grading.
3. Samples of the asphalt proposed for use in the mixture.
4. A temperature-viscosity curve for the asphalt.
5. When applicable, a sample of the portland cement, mineral filler, hydrated lime, fly ash, and/or the asphalt additive proposed.

The Agency will, at no cost to the Contractor, evaluate the proposed job-mix formula and suitability of the materials. If acceptable, a mix design will be developed within Agency requirements.

Should combinations of the Contractor stockpiles or source of materials change, a new mix design will be required prior to production. Development of the new mix design will require a minimum of ____ days.

Note: The Agency can utilize Option 1 or Option 2.

401.03 Construction Requirements

(a) Contractor Process Quality Control.

1. General Requirements. The Contractor shall administer a Process Quality Control Plan sufficient to assure a product meeting the contract requirements. The Plan shall meet the requirements of Subsection 106.04.
2. Elements of the Plan. The Plan shall address all elements which effect the quality of the asphalt concrete including, but not limited to the following:
 - a) Mix Design(s)
 - b) Aggregate Production
 - c) Quality of Components
 - d) Stockpile Management
 - e) Proportioning
 - f) Mixing, including temperature, addition of portland cement, mineral filler, hydrated lime, fly ash, and/or asphalt additive, if required.
 - g) Transporting
 - h) Placing and Finishing
 - i) Joints
 - j) Compaction, including Temperature
 - k) Smoothness
 - l) Thickness, when required.
3. Personnel Requirements. The Plan shall include the following technicians:
 - a) Process Control Technician(s) (PCT) shall utilize these results and other quality control practices to assure the quality of aggregates and other mix

components and adjust and control mix proportioning to meet the mix design(s). The Plan shall detail the frequency of sampling and testing, corrective actions to be taken, and documentation.

The PCT shall periodically inspect all equipment utilized in proportioning and mixing to assure it is operating properly and that proportioning and mixing is in conformance with the mix design and other contract requirements. The Plan shall detail how these duties and responsibilities will be accomplished and documented. The Plan shall include the criteria utilized by the PCT to reject or correct unsatisfactory materials.

- b) Quality Control Technician(s) (QCT) shall perform and utilize quality control tests at the job site to assure that the delivered materials meet the contract requirements. The QCT shall inspect all equipment utilized in transporting, placing, finishing, joint construction, compaction, and thickness, when required, conforms with the contract requirements. The Plan shall detail how these duties and responsibilities are to be accomplished and documented, and whether more than one QCT is required. The Plan shall include the criteria utilized by the QCT to reject or correct unsatisfactory materials.

- c) The Plan shall set for the coordination of the activities of the PCT and QCT.

- (b) *Other Requirements.* Refer to Agency requirements.

401.04 Acceptance. Asphalt concrete pavement will be sampled on a statistically random basis,

tested, and evaluated in accordance with Subsection 106.05. Evaluation of materials will be made using the following limits:

| Measured Characteristic | LSL | USL |
|-----------------------------|-----------------|-----------------|
| Gradation | | |
| 3/8-inch sieve | TV - 6.0% | TV + 6.0% |
| No. 8 sieve | TV - 6.0% | TV + 6.0% |
| No. 40 sieve | TV - 4.0% | TV + 4.0% |
| No. 200 sieve | TV - 2.0% | TV + 2.0% |
| Asphalt Content | TV - 0.50% | TV + 0.50% |
| Voids (optional) | TV - 1.5% | TV + 1.5% |
| Compaction | TV - 3.0% | TV + 3.0% |
| Thickness, when required | Plan - 0.25 in. | Plan + 0.25 in. |

Note: Agencies should establish LSL and USL for the gradations of the various asphalt concrete pavement mixes used.

401.05 Method of Measurement. Refer to Agency methods.

401.06 Basis of Payment. Refer to Agency methods and as noted below.

The asphalt concrete pavement contract unit bid price will be adjusted in accordance with Subsection 106.05. Payment for material in a lot will be made at a price determined by multiplying the contract unit bid price by the Composite Pay Factor (CPF). The following table will be utilized to calculate the Composite Pay Factor:

| Measured Characteristic | Factor "F" |
|-------------------------|------------|
| Gradation | |
| 3/8 inch sieve | 6 |
| No. 8 sieve | 10 |
| No. 40 sieve | 6 |
| No. 200 sieve | 20 |
| Asphalt Content | 50 |
| Voids (optional) | 50 |
| Compaction | 50 |

Note: Agencies should establish the factors "f" for gradations of various asphalt concrete pavement mixes used.

Section 501—Portland Cement Concrete Pavement

501.01 Description. This work consists of constructing a Portland cement concrete pavement on a prepared subgrade or base course.

501.02 Materials. Materials shall meet the requirements of the following Subsections:

| | |
|---------------------------|-----------|
| Fine aggregate | 703.01 |
| Course aggregate | 703.02 |
| Portland cement | 701.01 |
| Water | 712.01(a) |
| Air-entraining admixtures | 711.02 |
| Calcium Chloride | 712.02 |
| Joint filler | 705.01 |
| Curing materials | 711.01 |
| Reinforcing steel | 709.01 |
| Chemical admixtures | 711.03 |
| Fly ash | 712.04 |

Note: The Agency may substitute their own materials requirements.

501.03 Construction Requirements

(a) Contractor Process Quality Control.

1. General Requirements. The Contractor shall administer a Process Quality Control Plan sufficient to assure a product meeting the contract requirements. The Plan shall meet the requirements of Subsection 106.04.
2. Elements of the Plan. The Plan shall address all elements which affect the quality of the Portland cement concrete including, but not limited to the following:
 - a) Mix Design(s)
 - b) Aggregate Production

- c) Stockpile Management
- d) Quality of Components
- e) Proportioning, including Added Water
- f) Mixing and Transportation, including Time from Batching to Completion of Delivery
- g) Initial Mix Properties, including Temperature, Air Content, and Consistency
- h) Slump
- i) Placement and Consolidation
- j) Compressive or Flexural Strength
- k) Finishing and Curing
- l) Documentation and control charts
- m) Smoothness

Note: If the concrete mix design and/or aggregate sources are supplied or designated for use by the Agency, then certain elements of the plan should be adjusted accordingly.

3. Personnel Requirements. The Plan shall include the following technicians:

- a) Process Control Technician(s) (PCT) shall utilize test results and other quality control practices to assure the quality of aggregates and other mix components, and control and adjust mix proportioning to meet the mix design(s). The Plan shall detail the frequency of sampling and testing, corrective actions to be taken, and documentation.

The PCT shall periodically inspect all equipment utilized in proportioning and mixing to assure it is operating properly and that proportioning and mixing is in conformance with the mix design and other contract requirements. The Plan shall detail how these duties and responsibilities are to be accomplished and documented and whether more than one PCT is required. The Plan shall include the criteria utilized by the PCT to correct or reject unsatisfactory materials.

- b) Quality Control Technician(s) (QCT) shall perform and utilize quality control tests at the job site to assure that delivered materials meet the contract requirements and the mix design, including temperature, slump and air content. The QCT shall inspect all equipment utilized in transporting, placing, consolidating, joint construction, and finishing to assure it is operating properly and that placing, consolidation, joint construction, and finishing conforms with the contract requirements. The Plan shall detail the frequency of sampling and testing, corrective actions to be taken, and documentation. The Plan shall detail how these duties and responsibilities are to be accomplished and documented, and whether more than one QCT is required. The Plan shall include the criteria utilized by the QCT to reject unsatisfactory materials.
- c) The Plan shall set forth the coordination of the activities of the PCT and QCT.
- (b) *Other Requirements.* The Contractor shall provide a Certificate of Compliance for each truckload of concrete. The Certificate of Compliance shall include:
- Manufacturer's Plant (Batching Facility)
 - Contract No.
 - Name of Contractor (Prime Contractor)
 - Date
 - Time Batched/Time Discharged
 - Truck No.
 - Initial/Final Revolution Counter Reading
 - Quantity (Quantity Batched This Load)
 - Type of Concrete by Class or Producer Design Mix No.
 - Cement Brand, Type, and Shipment Certification No.
 - Approved Aggregate Gradation Designation
 - Target Weights Per Cubic Yard and Actual Batched
 - Weights for:
 1. Cement
 2. Fly ash (if used)
 3. Coarse concrete aggregate (each size)
 4. Fine concrete aggregate
 5. Water (including free moisture in aggregates)
 6. Temperature of mixing/discharge
 7. Admixtures brand and quantity per 100 wt.
 - Air-entraining admixture
 - Water reducing admixture
 - Other admixtures
 8. Combined monthly total of all concrete of all classes delivered to all Agency projects.
- Note:** Each Agency should modify this list to their own requirements. See AASHTO M157.
- The Certificate of Compliance shall be signed by a responsible representative of the concrete producer, other than the driver, affirming the accuracy of the information provided. In lieu of providing a machine produced record containing all of the above information, the concrete producer may use printed forms approved by the Agency.
- 501.04. Acceptance.** Portland cement concrete pavement will be sampled on a statistically random basis, tested, and evaluated in accordance with Subsection 106.05, and as noted below. Evaluation of materials will be made using the following limits:

| Measured Characteristic | LSL | USL |
|-------------------------|-----------|------------|
| Air Content | TV - 1.5% | TV + 1.5% |
| Strength | Design | None |
| Thickness | Plan | None |
| Smoothness | None | 7 in./mile |

- (a) *Concrete With Non-Conforming Strength.* Concrete produced in accordance with a Contractor-provided mix design which fails to meet the specified compressive strength at 28 days will be evaluated by comparison of the compressive test strength (fc) with the specified compressive strength (f'c) as follows:

1. If the (f'c - fc) value is less than 60 psi, the concrete will be accepted as being in conformance and no pay adjustment shall apply.
2. If the (f'c - fc) value is between 60 and 500 psi, the Engineer may:
 - a) Require corrective action at no additional expense to the Agency; or
 - b) Accept the concrete with a calculated pay adjustment as calculated below.
3. If the (f'c - fc) value is greater than 500 psi, the Engineer will:
 - a) Require the complete removal and replacement with concrete meeting the contract requirements at no additional expense to the Agency; or
 - b) Require corrective action at no additional expense to the Agency; or
 - c) Accept the concrete where the finished product is found to be acceptable for the intended purpose, with a payment adjustment as determined in Subsection 501.06(a).

Note: Each subplot will be analyzed separately for strength.

- (b) *Thickness.* Acceptance samples for thickness of the pavement will be taken after completion of any corrective work.
- (c) *Pavement Smoothness Surface Test.* The Contractor shall furnish paving equipment and employ methods that produce a riding surface having an average initial profile index of 7 inches per mile or less when tested with a California type profilograph using test method CA-526 (or substitute Agency method).

Note: Additional specifications for the operation of the profilograph, corrective grinding requirements, start-up paving procedures, and how the initial profile indexes will be taken, should be inserted here.

501.05 Method of Measurement. Refer to Agency methods.

501.06 Basis of Payment. Refer to Agency methods and as noted below:

- (a) *Concrete With Non-Conforming Strength.* The quantity of concrete represented by an acceptance test that fails to meet the specified compressive strength will be subject to the following pay adjustment:

$$\text{Pay Adjustment} = 0.0005 (f'c - fc) \text{ U.P.}$$

Where: f'c = specified compressive strength at 28 days

fc = compressive strength at 28 days.

U.P. = unit contract price per square yard for the concrete pavement involved. Where payment for the item is on a lump sum basis, the unit price of concrete payment shall be

taken as \$70.00 per square yard for concrete pavement.

Note: Strength is analyzed for pay adjustment only and is not eligible for bonus payment.

- (b) *Smoothness.* When the average initial profile index for the lot is greater than 7 inches per mile, the Contractor will take corrective grinding action to bring the defective sections equal to or below the 7 inches per mile criteria. When the average initial profile index is less 7 inches per mile, the Contractor is entitled to an incentive payment. Contract unit price adjustment will be made in accordance with the following schedule. The maximum bonus payment for smoothness is 3 percent.

| Initial Profile Index | Pay Adjustment Factor |
|--------------------------------------|------------------------------------|
| Inches per mile per 0.1-mile section | Percent of Pavement unit bid price |
| > 2.0 | 103.00 |
| 2.0 to 2.9 | 102.50 |
| 3.0 to 3.9 | 102.00 |
| 4.0 to 4.9 | 101.50 |
| 5.0 to 5.9 | 101.00 |
| 6.0 to 6.9 | 100.50 |
| 7.0 | 100.00 |

Pay adjustments will be based on the average initial profile index for the lot prior to any corrective work.

- (c) *Composite Pay Factor (CPF).* The Portland Cement Concrete Pavement contract unit bid price will be adjusted in accordance with Subsection 106.05. Payment for material in a lot will be made at a price determined by multiplying the contract unit bid price by the composite pay factor. The maximum bonus for air content and thickness is 2 percent. See Appendix E for an example of the calculations involved when composite pay factors are used. The following table will be utilized to calculate the Composite Pay Factor:

| Measured Characteristic | Factor "F" |
|-------------------------|------------|
| Air Content | 50 |
| Thickness | 50 |

Section 603 — Pipe Culverts

603.01 Description. This work consists of furnishing and installing concrete and metal culverts, storm drains, and cattle passes.

603.02 Materials. Refer to Agency requirements.

603.03 Construction Requirements

(a) *Contractor Quality Control.*

1. General Requirements. The Contractor shall administer a Process Quality Control Plan sufficient to assure a product meeting the contract requirements. The Plan shall meet the requirements of Subsection 106.04.
2. Elements of the Plan. The Plan shall address all elements which affect the quality of the pipe culvert installation, including, but not limited to, the following:
 - a) Moisture
 - b) Compaction
 - c) Bedding
3. Personnel Requirements. The Plan shall include the following technician(s).

Quality Control Technician(s) (QCT) shall perform and utilize quality control tests at the job site to assure that the installation of pipe culverts meets the contract requirements. The Plan shall detail the frequency of sampling and testing, corrective actions to be taken, and documentation.

The QCT shall periodically inspect all equipment utilized in the placement of the pipe culvert to assure it is operating properly and that the placement of the pipe culvert conforms to the contract requirements. The Plan shall detail how these duties and responsibilities are to be accomplished and documented, and whether more than one individual is required. The Plan shall include the criteria utilized by the QCT to reject unsatisfactory pipe culvert installations.

- (b) *Other Requirements.* Refer to Agency requirements.

603.04 Acceptance. Pipe culvert installations will be sampled on a statistically random basis, tested, and evaluated in accordance with Subsection 106.05(a), Quality Level Analysis, using steps 1 thru 7 only. Acceptance will be at an 85 percent quality level with all material below that level reworked. Evaluation of materials will be made using the following limits:

| Measured Characteristic | LSL | USL |
|-------------------------|----------------------------|----------------------------|
| Moisture | TV - 2% | TV + 2% |
| Density | 95% Max. Density | None |
| Gradation | TV - (Specified by Agency) | TV + (Specified by Agency) |

Note: Agencies should establish LSL and USL for the gradations of the various backfill materials used.

603.05 Method of Measurement. Refer to Agency methods.

603.06 Basis Of Payment. Refer to Agency methods.

Note: If pay is to be adjusted in accordance with 106.05, the Agency must establish the factors "f" for gradations of various backfill materials used. See Subsection 401.06 for an example

of the use of these factors.

Section 621 — Structural Concrete

621.01 Description. This work consists of furnishing, placing, and curing structural concrete for use in bridges, culverts and other structures.

621.02 Materials. Materials shall meet the requirements of the following Subsections:

| | |
|--------------------------|--------|
| Portland cement | 701.01 |
| Fine aggregate | 703.01 |
| Coarse aggregate | 703.02 |
| Lightweight aggregate | 703.16 |
| Curing materials | 713.01 |
| Air-entraining admixture | 713.02 |
| Chemical admixtures | 713.03 |
| Water | 714.01 |
| Fly ash | 714.11 |

Note: Agencies may substitute their own materials specifications.

621.03 Construction Requirements

(a) *Contractor Process Quality Control*

1. General Requirements. The Contractor shall administer a Process Quality Control Plan sufficient to assure a product meeting the contract requirements. The Plan shall meet the requirements of Subsection 106.04.
2. Elements of the Plan. The Plan shall address all elements which affect the quality of the structural concrete including, but not limited to the following:
 - a) Mix Design(s)
 - b) Aggregate Production
 - c) Quality of Components
 - d) Stockpile Management
 - e) Proportioning, including Added Water
 - f) Mixing and Transportation, including Time from Batching to Completion of Delivery

- g) Initial Mix Properties including Temperature, Air Content, and Consistency
 - h) Placement and Consolidation
 - i) Compressive Strength
 - j) Finishing and Curing
3. Personnel Requirements. The Plan shall include the following technicians:
- a) Process Control Technician(s) (PCT) shall utilize test results and other quality control practices to assure the quality of aggregates and other mix components and control proportioning to meet the mix design(s). The Plan shall detail the frequency of sampling and testing, corrective actions to be taken, and documentation. The PCT shall periodically inspect all equipment utilized in proportioning and mixing to assure it is operating properly and that proportioning and mixing conforms with the mix design(s) and other contract requirements. The Plan shall detail how these duties and responsibilities are to be accomplished and documented, and whether more than one PCT is required. The Plan shall include the criteria utilized by the PCT to correct or reject unsatisfactory materials.
 - b) Quality Control Technician(s) (QCT) shall perform and utilize quality control tests at the job site to assure that delivered materials meet the requirements of the mix design(s), including temperature, slump, air content and strength. The QCT shall inspect all equipment utilized in transporting, placing, consolidating, finishing and curing to assure it is operating properly and that placement, consolidation, finishing and curing conform with the contract requirements. The Plan shall detail frequency of sampling and testing, corrective actions to be taken, and documentation. The Plan shall detail how these duties and responsibilities are to be accomplished and documented, and whether more than one QCT is required. The Plan shall include the criteria utilized by the QCT to reject unsatisfactory materials.
 - c) The Plan shall detail the coordination of the activities of the PCT and the QCT.
- (b) *Other Requirements.* The Contractor shall provide a Certificate of Compliance for each truckload of concrete. The Certificate of Compliance shall include:
- Manufactured Plant (Batching Facility)
 - Contract No.
 - Name of Contractor (Prime Contractor)
 - Date
 - Time Batched/Time Discharged
 - Truck No.
 - Initial/Final Revolution Counter Reading
 - Quantity (quantity batched this load)
 - Type of Concrete by Class or Producer Design Mix No.
 - Cement Brand or Type, and Shipment Certification No.
 - Approved Aggregate Gradation Designation
 - Target Weights Per Cubic Yard and Actual Batched Weights for:
 - 1. Cement
 - 2. Fly Ash
 - 3. Coarse Concrete Aggregate
 - 4. Fine Concrete Aggregate
 - 5. Water (including free moisture in aggregates)
 - 6. Temperature of Mixing/Discharge
 - 7. Admixtures Brand and Quantity per 100 wt.
 - Air-Entraining Admixture
 - Water Reducing Admixture
 - Other Admixtures
 - 8. Combined Monthly Total of All Concrete of All Classes Delivered to All Agency Projects.

Note: Each Agency should modify this list to their own requirements. See AASHTO M157.

The Certificate of Compliance shall be signed by a responsible representative of the concrete producer, other than the driver, affirming the accuracy of the information provided. In lieu of providing a machine produced record containing all of the above information, the concrete producer may use printed forms approved by the Agency.

621.04 Acceptance. Structural concrete will be sampled on a statistically random basis, tested, and evaluated in accordance with Subsection 106.05 and as noted below. Evaluation of materials will be made using the following limits:

| Measured Characteristic | LSL | USL |
|-------------------------|--------------|--------------|
| Slump | TV - 1.0 in. | TV + 1.0 in. |
| Air | TV - 1.0% | TV + 1.0% |
| Strength | Design | None |

(a) *Additional Samples.* The first load of concrete placed will be sampled, tested, and evaluated for quality determination. Concrete will also be tested whenever there is a change shown on the Certificate of Compliance or visual change in the mix. Concrete properties shall be determined from concrete delivered to the project and certified by the Contractor for quality testing prior to placement.

(b) *Corrective Action.* Concrete placement operations shall be suspended when the pay factor as determined in accordance with Subsection 106.05 for a lot:

1. Drops below 1.0000 and the Contractor is taking no corrective action, or
2. Is less than 0.9000.

The placement operations shall not resume until the Engineer determines that material meeting the contract requirements can be produced.

Any lot with a pay factor of less than 0.9000 will be rejected.

(c) *Concrete With Non-Conforming Strength.* Concrete produced in accordance with a Contractor-provided mix design which fails to meet the specified compressive strength at 28 days will be evaluated by comparison of the compressive test strength (f_c) with the specified compressive strength (f'_c) as follows:

1. If ($f'_c - f_c$) is less than 60 psi, the concrete will be accepted as being in conformance and no pay adjustment shall apply.
2. If the ($f'_c - f_c$) value is between 60 and 500 psi the Engineer may:
 - a) Require corrective action at no additional expense to the Agency; or
 - b) Accept the concrete with a calculated pay adjustment as calculated below.
3. If the ($f'_c - f_c$) value is greater than 500 psi, the Engineer will:
 - a) Require the complete removal and replacement with concrete meeting the contract requirements at no additional expense to the Agency; or
 - b) Require corrective action at no additional expense to the Agency; or
 - c) Accept the concrete where the finished product is found to be acceptable for the intended purpose, with a pay adjustment as determined in Subsection 621.07(a).

Note: Each subplot will be analyzed separately for strength.

621.06 Method of Measurement. Refer to Agency methods.

621.07 Basis of Payment. Refer to Agency methods and as noted below:

- (a) *Concrete With Non-Conforming Strength.*
The quantity of concrete represented by an acceptance test that fails to meet the specified compressive strength will be subject to the following pay adjustment.

$$\text{Pay Adjustment} = 0.0005 (f'c - fc) \text{ U.P.}$$

Where: $f'c$ = specified compressive strength at 28 days

fc = compressive strength at 28 days

U.P. = unit contract price per cubic yard for the class of concrete involved.
Where payment for the item is on a lump sum basis, the unit price of concrete shall be taken as \$300.00 per cubic yard for

concrete Class ____, ____, and ____.
For concrete Class ____ the unit price for concrete shall be \$150.00 per cubic yard.

- (b) *Composite Pay Factor (CPF).* The Portland Cement Concrete Pavement contract unit bid price will be adjusted in accordance with Subsection 106.05. Payment for material in a lot will be made at a price determined by multiplying the contract unit bid price by the composite pay factor. The following table will be utilized to calculate the Composite Pay Factor:

| Measured Characteristic | Factor "F" |
|-------------------------|------------|
| Slump | 40 |
| Air Content | 60 |

HIGHWAY SUBCOMMITTEE ON RIGHT-OF-WAY

of the Standing Committee on Highways

Corridor Preservation

ROBERT HELMANDOLLAR
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Before speaking about Corridor Preservation, I wanted to find out what it was—exactly. So I started with the dictionary. Mr. Webster told me that preservation is the “act of preserving.” O.K. To preserve is to “save from decomposition,” “to can, pickle, or similarly prepare for future use.” That’s close, but not quite what I was looking for. But wait, another definition is “to keep up and reserve for personal or special use.”

Yes, that’s it. Freeway Corridor Preservation is the application and coordination of various methods to reserve the designated corridor for special use. In this case, for the future construction of a transportation facility.

Alright, that’s what it is, but why would we want to preserve a corridor anyway? It sounds to me like it could be a lot of trouble. Well, I asked around and found out that there are several reasons why we might want to preserve a corridor.

Failure to protect a corridor from development could force the whole project into another less desirable alignment.

Freeway Corridor Preservation is the application and coordination of various methods to reserve the designated corridor for special use. In this case, for the future construction of a transportation facility.

It provides for consistent land-use planning, and coordinated long-term development.

It can reduce costs to acquire right-of-way, particularly if development is controlled.

It reduces the number of relocations and minimizes social and economic impacts.

And it permits orderly and progressive development of the project over a longer period of time.

But just as I suspected, corridor preservation is not all that easy to do. It requires the dedication and

cooperation of many persons in both the public and private sector. It requires the application of several techniques, often with varying degrees of success. Considerations such as when construction of the facility is to begin, the activity of development within the corridor area, the status of the general real estate market, and the level of development already existing within the corridor, can help us determine whether, or which, preservation actions should be initiated.

Unless an agency has the funding required to purchase all the right-of-way up front on major corridors (and we don't) you have to come up with some innovative ways to preserve, reserve, and purchase.

Corridor preservation isn't really a new idea. The Arizona Department of Transportation has employed methods of preservation in the past. The most notable was the advance acquisition, with federal "Q" funds, of the right-of-way for S.R. 360, a.k.a., the Superstition Freeway, about fifteen years ago. This was corridor preservation at its simplest and most effective. Identify the right-of-way you need and go out and buy it.

But that was then, and this is now. In October 1985, the voters of Maricopa County (comprising Phoenix and the surrounding cities and towns) overwhelmingly approved Proposition 300 for a countywide, half-cent sales tax to be devoted to the construction of facilities on the Maricopa Association of Governments, or MAG, plan. All of the funds generated, except for approximately \$200 million devoted to transit, were to be used for design, right-of-way purchase and construction of controlled access facilities on the MAG Freeway/Expressway Plan.

Another source of funding, the Highway Users Revenue Fund (HURF), is made up of user taxes

and fees paid to the State of Arizona including gasoline taxes, vehicle registration fees, license plate fees and taxes on trucks. Legislation requires that a specific portion of these revenues (MAG 15% funds) be used by ADOT to construct controlled access highways in the Phoenix metropolitan area. Property taxes, State income taxes and Arizona lottery funds are not used.

The schedule for completion of the entire 231-mile MAG Freeway/Expressway Plan is driven to a major extent by the availability of funding. In 1985 the MAG Transportation half-cent sales tax was projected to raise \$5.8 billion over its 20-year life. In 1986, this projection was revised upward to \$6.0 billion. The current projection is \$4.0 billion—a decrease of 33 percent. Reasons for this decrease include the unanticipated severity of the economic slowdown, and a change in the long-term growth prospects stemming from this slowdown.

The total cost of the MAG Freeway Plan is now estimated at \$6.1 billion. The current cost estimates show total right-of-way acquisition costs as \$2.0 billion, while total design/construction costs are expected to be \$4.1 billion.

Many recent newspaper articles have highlighted concerns about increasing costs and delays in completing the system. Unless an agency has the funding required to purchase all the right-of-way up front on major corridors (and we don't) you have to come up with some innovative ways to preserve, reserve, and purchase.

The adoption over the last five years of the several corridors comprising the MAG Freeway/Expressway system has placed particular emphasis on corridor preservation. Some of these corridors are not scheduled for completion for ten to fifteen years. Some of these corridors are located in areas of rapid development. If left "unattended" by us, today's farmland could be filled with subdivisions and commercial development by the time we're ready to construct. And irrespective of development, and notwithstanding the present state of the economy, real estate values will most likely rise, increasing the cost to purchase right-of-way.

As I have mentioned, we had dabbled in corridor preservation before. But the MAG system, and its 231 miles of freeway corridors has motivated us to devise various new techniques to preserve as much right-of-way as possible. Here are a few of the things we are doing.

Funding levels dictate the scope of the Advance Acquisition program.

ADOT has a long-standing Advance Acquisition Program. The purpose of this program is to purchase properties within a corridor in advance of full scale acquisition to alleviate hardships or forestall development.

We recognize the responsibility to address those situations where a property must be sold due to medical or financial hardship but is not marketable because of its location within a designated transportation corridor. We also wish to forestall development that would significantly increase right-of-way acquisition and relocation costs at a later date.

Our Advance Acquisition office receives and evaluates all requests for early acquisition. They document hardship situations in order to justify approval to purchase. Owners of commercial property must demonstrate a commitment to develop before being seriously considered for Advance Acquisition.

Along with owner-initiated requests we have established a procedure with some of the local governments that identifies potential zoning changes or development within our corridors. Known as the "Red Letter Process" it calls for the local government to notify ADOT when requests for zoning changes or building permits are submitted for properties in or near a corridor. ADOT then reviews the information provided and returns its comments to the local agency. Significant requests are referred to our Advance Acquisition office for further investigation, and possible approval for purchase.

Funding levels dictate the scope of the Advance Acquisition program. Abundant funding (there should ever be such a thing!) allows us to respond to a broad range of hardship and development situations. Limited funding severely restricts our ability to respond. Recently, funding has been such that only residential, owner-occupied properties where a severe hardship existed could be considered.

But necessity is the mother of invention. If we can't buy the high-dollar properties for cash to forestall development or alleviate a hardship, then we can use other methods. House Bill 2051, passed this last year by the Arizona legislature, permits ADOT to purchase property in ways other than cash.

One way is through the Time-Payment Method, which provides an opportunity to acquire properties for little or no cash down, with payments extended over several years. The proposals we receive from property owners for Time Payment Purchase must reflect an opportunity for the State to realize a significant financial advantage by purchasing the property at the present time. In order to qualify for a Time Payment purchase, a property must first meet the established criteria of the Advance Acquisition program to forestall development or alleviate a hardship. Usually the property would be located in a project section that is not scheduled for construction within the next five years. In addition, we would consider a purchase price that is advantageous to the State, considering present and future value, minimal or no down payment requirements, and no interest or interest rates significantly below the current bond rate. A combination of these items should reflect an overall advantage to the State.

Representatives from our Right-of-Way Section, Engineering Section, Transportation Planning Division, and Administrative Services Division evaluate each proposal. If sufficient cost advantages for the State exist, a recommendation would go to the Deputy State Engineer for final approval.

We would not go to condemnation if a value dispute arose or clear title could not be delivered.

Three Time Payment Advance Acquisition proposals have been approved. The terms vary for each. But generally, the purchase prices are considered to be below fair-market value, down payments are small (around 10 percent) or none at all, interest rates are advantageous, and additional concessions were received from the sellers. These Time Payment purchases are set up to be paid off prior to when the property will be needed for construction.

The same legislation (House Bill 2051) allows us to consider Options to Purchase as another means of securing right-of-way. An Option to Purchase is a conditional contract in which one party is given the right to buy a property under specified conditions within a certain period of time for consideration paid to the seller.

The present real estate market in this area is such that acquisition of Options to Purchase is reasonable. Options allow us to acquire property at today's value, but at a future date. Options can preserve the right-of-way by including provisions precluding the owner from changing the condition of the property during the term of the option. An Option effectively removes the property from the market, giving the State first right of refusal.

In today's sluggish economy and reduced revenues the local governments are increasingly aware that they must be active participants in the highway development process.

We haven't yet had the pleasure of entering into any Options, but hope to soon so we can spread out the available funding and take advantage of the current "buyers" market.

Other recent legislative action, House Bill 2110, permits the Department to enter into negotiations and purchase property at a price *mutually acceptable* to the property owner and the Department for

property that is expected to be needed for future transportation facilities. This legislation applies only to qualified advance acquisitions of properties that are located within projects for which, at the time of purchase, no construction is scheduled in the current Five-Year Construction Program. This is innovative. It allows us to not just accept proposals for advance acquisition, but to actually sit down with the owner and negotiate a purchase price.

We are assertively working with the real estate community, local lenders, even the Resolution Trust Corporation in order to identify properties within our freeway corridors that may be candidates for Time Payment, Options, or negotiated purchase. We're excited about the possibilities.

Under certain circumstances we are able to acquire right-of-way without paying for it. Not that we sneak out and steal it while no one is looking. Instead we reach agreement with a property owner or local government to receive the right-of-way in exchange for certain actions on our part.

We have been successful in obtaining donations from individual property owners. To date, the most significant donations have come on the Estrella corridor west of Phoenix. In exchange for our agreement to construct a two-lane, interim roadway within the next two years, The Department received 605.67 acres of donated right-of-way. This was three quarters of all right-of-way needed to construct the ultimate freeway design, which is not expected to be completed until well after the year 2000.

Putting together a donation package involving this much acreage and twenty-three separate owners wasn't easy. There were a great many details to address with each owner before clear title could pass to the State. But it was worth it! And we hope that success in obtaining donations on this corridor will lead to similar successes on other corridors.

Donations of another fashion have been obtained from local governments. Land acquired by the city or town has been given to us in exchange for accelerated construction or certain features desired by

the local government that we incorporate into the design of the facility. These features may be minor, such as lighting or landscaping, or as significant as a traffic interchange. Of course, the addition of these features must be cost effective as related to the value of the right-of-way we receive.

In today's sluggish economy and reduced revenues the local governments are increasingly aware that they must be active participants in the highway development process. Many of these governments have assumed a larger role in preserving the right-of-way, as well as participating in the expense of construction.

Our previous discussion of the "Red Letter Process" spoke well of the cooperation between ADOT and the local governments in addressing potential development within the freeway corridors. It is also through the planning and zoning process of the local governments that "clean take" lines can be established and right-of-way can be extracted from property owners and developers. For changes in zoning or development density, the cities and towns can obtain dedications of right-of-way and provide for uniform, undisturbed development along the freeway corridors.

Another form of cooperation is evidenced by highway projects jointly funded with the local governments. In response to the announcement of major delays in freeway construction, the local governments were willing to contribute funds to speed construction within their boundaries.

In response to the announcement of major delays in freeway construction, the local governments were willing to contribute funds to speed construction within their boundaries.

ADOT's Highway Development Group's Urban Highway Section has implemented cost-sharing

ventures designed to accelerate construction on segments of the urban freeway system. They formed partnerships with the cities of Scottsdale, Mesa, Phoenix and Chandler, and to a lesser extent with private landowners, for construction of portions of the Pima, Red Mountain, and Squaw Peak freeways, and the Price Expressway.

Although we're optimistic that a rebounding economy will generate increased tax revenues, or that legislative action will do the same, nothing is certain.

The Arizona State Transportation Board has allocated \$10 million a year over the next five years for projects jointly funded with local governments.

Although Joint Funding at present primarily involves funding for construction, often some sort of right-of-way transfer is part of the deal. Besides, any funds contributed toward completion of these corridors is helpful to the system as a whole.

In all of these matters, it seems we're always talking about funding, specifically limits thereon, or lack thereof. ADOT is no different from many other DOT's in feeling the economic pinch. Many of the methods we have been discussing were devised to more effectively use the funds that are available.

To supplement our funding, we've established a procedure to channel revenue derived from sale of excess land within the Maricopa Association of Government system and net income obtained through the lease/rental of Department owned property into the Advance Acquisition program. We expect that this additional funding will amount to 4 or 5 million dollars per year, giving quite a boost to the program.

In another area of funding, our friends at the Federal Highway Administration have advised us that additional "Q" funds may be available next fiscal year, and that they are also considering the transfer of "Q" funds to other qualified projects. We remain hopeful.

Although we're optimistic that a rebounding economy will generate increased tax revenues, or

that legislative action will do the same, nothing is certain. We must work within the present conditions, whatever they may be. The various methods we have discussed have enhanced our ability to preserve present or future transportation corridors. But we're still not satisfied. We're going to continue to look for other innovative ways to reserve those corridors designated for special use. Only by doing this can we best serve the Public.

HIGHWAY SUBCOMMITTEE ON TRAFFIC ENGINEERING

of the Standing Committee on Highways

Arizona's Freeway Management Programs

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The State of Arizona continues to experience the same dynamic growth patterns that began some years ago. Its mild climate and proximity to west coast markets have made the Grand Canyon State an ideal location for business expansion and for establishing western operations.

This growing economy has brought with it many benefits and challenges for the state at large. One of these challenges has been the need to provide adequate transportation facilities for the ever expanding metropolitan Phoenix area. A recent Department of Commerce report lists Phoenix as one of the seven fastest growing metropolitan areas in the next decade. That same study ranks Phoenix as third in job and population growth through the year 2000. With an existing population of 2 million people, the Valley of the Sun has, and will continue to have, a significant demand for transportation facilities.

Providing an adequate transportation system for the expanding population is one of the major challenges facing the Arizona Department of Transportation (ADOT) today. Realizing that a comprehensive transportation system does not occur from a

casual approach to the problem, the Arizona Department of Transportation has embarked on an ambitious program to meet the transportation needs of the Phoenix metropolitan area for the nineties and into the 21st century.

ADOT's approach to managing a growing demand for freeway transportation facilities, and to maximize the freeway system as it exists today, is embodied in a comprehensive two-part plan. The first part consists of providing an ambitious freeway construction program in order to establish a basic transportation structure for public use. The second part of the plan is to maximize the capacity of this transportation system as it exists today and better meet the needs of the future. The implementation of a freeway management system that accomplishes this second goal is the subject of this paper.

As noted previously, the Arizona Department of Transportation has embarked on a program to improve the basic transportation facilities of the Phoenix metropolitan area. Foremost in this effort is the construction of a 231-mile loop freeway system connecting the various communities making up the

greater Phoenix area. This loop freeway system is funded by a voter approved 1/2-cent sales tax program. Since 1985, over \$1 billion have been spent toward the development and construction of these roadways. Expected to be completed within a 15-year period, the Outer Loop Freeway System will significantly change the travel patterns and the basic demographics of the Valley of the Sun.

Recognizing that additional freeway miles would not solve all of the transportation demands of the Phoenix metropolitan area, ADOT determined that a comprehensive Freeway Management System should be implemented in order to maximize the available freeway capacity. In 1987 the planning and design for just such a system began.

ADOT's plan was intended to address both types of traffic congestion. These two types of congestion, namely recurring and non-recurring, reduce capacity, cause accidents, and contribute significantly to driver frustration.

Non-recurring congestion can take many forms. It can be as simple as a motorist who needs assistance for a minor vehicular repair. Or it can be as serious as a hazardous materials incident in a populated area. Characterized by their unpredictability, these non-recurring incidents are major contributors to congestion in Phoenix and serve to reduce the capacity of the freeway system.

In 1987, the Arizona Department of Transportation began the development of a freeway management system for the Phoenix metropolitan area. The purposes of ADOT's Freeway Management System are the following:

- a. Reduce Congestion
- b. Maximize Freeway Capacity
- c. Manage Incidents

ADOT's Freeway Management System is scheduled to be completed in five phases over the next seven years. Each phase is designed to provide a logical building block in the overall system. Rather

than a series of individual projects, they will appear to the public as system expansions and will immediately compliment one another.

Initially, ADOT's Freeway Management System will be installed on 99 miles of urban freeway corridors. Ultimately, this system will be installed on 223 miles within the greater Phoenix metropolitan area.

The ADOT Freeway Management System will consist of a number of individual components. They are:

- a. Loop Detector System
- b. Closed Circuit Television (CCTV)
- c. Variable Message Signs (VMS)
- d. Ramp Metering
- e. Highway Advisory Radio (HAR)
- f. Traffic Interchange Signals
- g. Lane Use Control Signs
- h. Tunnel Monitoring System
- i. Public Information System

Each of these systems is considered as being effective in their specific role in freeway management. However, the real power comes when two or more work together to compliment and improve the system. ADOT's Freeway Management System includes all of these individual components resulting in a powerful and effective approach to freeway capacity management.

A short description of the individual system components will serve to detail their role in the overall system.

The Loop Detector System will be installed throughout the corridors covered by the Freeway Management System. These loops will be spaced at an interval of approximately 1/3 of a mile. Research

done on Arizona pavement types has resulted in a loop design that will be sensitive enough to determine both speed and headway. This information will then be transmitted to the Freeway Operations Center and analyzed by computers using custom algorithms. This raw data will be processed and utilized to control and adjust other parts of the overall system. Such systems as Ramp Metering, Variable Message Signs, Highway Advisory Radios and others will key off of data collected from these loop detectors.

Closed Circuit Television Cameras will be an integral part of ADOT's Freeway Management System. One of the problems with attempting to manage freeway traffic is the inability to have real time information upon which to base decisions. Some agencies have attempted to overcome this obstacle through the use of field units that patrol specific routes. However, with this approach, timely incident detection is subject to how soon the patrol vehicle reaches the scene and determines the nature of the problem.

The ADOT Freeway Management System will utilize Closed Circuit Television cameras located at one mile intervals, mounted halfway between the one mile traffic interchange. They will have full pan, tilt, and zoom capabilities giving the personnel in the Freeway Operations Center the ability to verify and evaluate incidents as they occur and make real time decisions on how to respond. A total of 133 cameras will provide control room operators with a first hand view of the Phoenix Urban Freeway System.

Discussions have occurred with the Phoenix Fire Department in order to develop a plan to provide this video feed directly to their Tactical Operations Center. This will allow the Fire Department to more effectively direct the deployment of their units to an incident.

Another important system for managing ADOT's freeway corridors will be the Variable Message Signs located strategically throughout the Phoenix metropolitan area. A total of 80 signs will be purchased and installed over the next seven years as part of the first 116 miles of Arizona's Freeway

Management System. These signs will be capable of providing messages composed of three lines of eighteen characters each. As incidents occur or there is other pertinent information to communicate to the traveling public these signs will be used to fulfill this role.

ADOT is concerned about the very dynamic nature of the Variable Message Sign technology. Therefore, it was felt that a commitment to purchase 80 Variable Message Signs should be made with a full knowledge of the long-term implications of the selected sign type. To this end, ADOT is currently in the process of researching and testing three types of signs. These three types are:

- a. LED
- b. Fiber Optic
- c. Flip Disk

This research is being conducted as part of the construction activities associated with current freeway widening project. ADOT is installing a total of six Variable Message Signs to alert motorists to current construction conditions. A life-cycle cost analysis will be one of the factors used to determine the best sign type to be used for ADOT's Freeway Management System in addition to the operational testing and research being performed by Arizona State University. When this research is completed, in the spring of 1991, the type of model of Variable Message Sign to be installed over the first 116 miles of the system will be determined.

Another component of Arizona's Freeway Management System is Ramp Metering. ADOT currently utilizes ramp metering on 9 miles of Interstate 17 with a total of 13 ramps being thus controlled. This system of ramp meters will be expanded to 139 ramps over the next seven years. Ramp metering will be an integral part of the overall Freeway Management System. During periods of recurring congestion, these ramp meters will operate and control on-ramp flow based on mainline traffic conditions. When incidents occur, ramp metering will also be able to respond to the changing condi-

tions on the freeway offering very specific timing to best manage traffic flow.

The Tunnel Management System is a unique feature of the Freeway Management System in Phoenix. It was necessitated due to the recent completion of the I-10 Deck/Tunnel located in downtown Phoenix. This unique feature in ADOT's freeway system consists of a 1/2 mile long tunnel facility containing 12 lanes of traffic split among three tubes.

The Tunnel Management System controls many subsystems necessary for the safety of the traveling public. These subsystems include ventilation fans, tunnel lighting, carbon monoxide detection systems, radio rebroadcast equipment and motorist assistance telephones. Currently, these systems are operated from the tunnel control room located at the I-10 Deck/Tunnel.

Complex in its own right, the Tunnel Management System requires full time monitoring by members of the Freeway Operations Center staff. ADOT has recognized the need to include the I-10 Deck/Tunnel as a part of the overall system rather than as a separate entity. After the Freeway Operations Center is completed in mid-1991, the operational functions will then be brought in from the Tunnel Control Room. This philosophy of consolidating all freeway management activities will continue as two more tunnels at the Price Road Interchange are added to the system in 1993.

Highway Advisory Radio (HAR) is another system to be utilized by ADOT's Freeway Management System. Indented to provide up to date information to the public, HAR will be installed along key corridors on the Phoenix Freeway System. Information, broadcast by low power transmitters located strategically along the freeway system, will keep drivers informed of changing freeway conditions. Custom digitized messages will be generated based on current freeway conditions, providing timely information to affected motorists.

At this time, ADOT is considering an experimental project on Lane Use Control Signs. Cur-

rently, ADOT's use of the signs is limited to the I-10 Deck/Tunnel where they serve to alert motorists to changing lane conditions in the tunnel proper. In order to further evaluate the value of Lane Use Control Signs on the Phoenix freeway system, ADOT has elected to install a test section of I-17, which is one of the major corridors used each day. Should they prove effective, Lane Use Control Signs will be installed on selected segments in conjunction with the remainder of Arizona's Freeway Management System.

ADOT's Freeway Management System is an ambitious undertaking that will significantly improve traffic flow in Phoenix. Non-recurring congestion has been, and will continue to be, a problem on the urban freeway system. Responding to this need to mitigate non-recurring congestion, ADOT has implemented the ALERT Team.

The ALERT Team was first started in 1986 in ADOT's District I, with headquarters in Phoenix. Their mission or purpose is to deal with the non-recurring incidents on the Phoenix area freeway system.

The ALERT Team has two specific goals:

1. Establish the necessary traffic control to deal with the immediate incident and insure the safety of the traveling public.
2. Restore full traffic flow as soon as possible.

The ALERT Team is not a courtesy patrol. Nor do they have any law enforcement role. Rather, their primary purpose is to minimize the impacts of an incident on the traveling public.

The personnel selected to serve on the ALERT Team are senior technicians who have demonstrated sound judgment and who possess exceptional traffic control skills. They typically hold staff positions in the District Office which gives them the flexibility to respond to incidents on a moments notice.

Special 3/4 ton pickups have been outfitted for the ALERT Team in order to assist them in accom-

plishing their incident response duties. Due to the unpredictability of these incidents, they carry a wide range of tools and equipment in order to meet the unexpected needs of a particular situation. Special nylon signs are used because of their light weight and ease of storage. They have excellent visibility and can be placed very quickly. Sufficient traffic cones are available for short-term lane or freeway closures with additional equipment brought to the site by road maintenance crews if more permanent detouring is necessary. If the incident occurs at night then the cones are outfitted with reflective tape or collars to improve safety and provide additional visibility for the traffic control in place.

The ALERT Team is on call 24 hours a day, 7 days a week, 365 days a year. Two alternates provide backup when the primary members are not available.

Over the years, the Arizona Department of Transportation has developed an excellent working relationship with the Department of Public Safety. When an incident first occurs, it is typically the Officer from the DPS who is the first on the scene. Initially, they are forced to deal with both the incident itself and the resulting traffic congestion. The goal of the ALERT Team is to respond to incidents quickly in order to relieve the Department of Public Safety from the traffic control role and allow them to concentrate on their law enforcement duties. Experience has shown that the incident is most effectively handled if the law enforcement and the transportation units each do what they do best and allow the other to do the same.

Communication is the key to an effective response to freeway incidents. Each ALERT Team vehicle is equipped with a two-way radio for communication with other ADOT units, such as road maintenance crews or construction crews who may be affected by the impacts of the incident.

Historically, one of the problems that impacted ADOT's incident response was communications with the Department of Public Safety and local fire and medical units. This was due to the fact that each operated on a separate radio network. Often, the

nature of an incident would change from the time the ALERT Team units were dispatched and the time that they arrived on the scene. In addition, once on the scene, the ALERT Team had no way of communicating with ADOT District management without searching out a public phone somewhere. This situation was unacceptable for a program that was dedicated to improving and managing congestion on Arizona's freeway system.

The solution to both of these problems was to install cellular phones in each of the ALERT Team vehicles. A similar effort on the part of the Department of Public Safety has essentially eliminated this serious communication problem. Today, ALERT Team members can communicate with other public safety agencies; they can notify ADOT District management regarding the nature of an incident; they can call out additional road maintenance personnel and equipment; and they can communicate sensitive information over their phones that normally would have been inappropriate to broadcast over the open airwaves.

The ALERT Team is equipped to handle both traffic control duties and routine maintenance activities. Often, an incident requires some cleanup of the roadway or removal of damaged features such as glare screen or signs. In the past, it was necessary to call out the local ADOT road maintenance crew in order to effect the repair or cleanup operation. This usually further delayed the reopening of the roadway to full traffic flow.

Today this has all changed. With one of the goals of the ALERT Team being the timely restoration of full traffic flow, each member is equipped to handle many of the routine cleanup activities. Recognizing that many of the maintenance activities can be accomplished by a small work force with a few specific tools, it was determined that the ALERT Team could perform many of these duties and return the road to normal traffic flow sooner. Thus, rather than wait for a road maintenance crew to arrive on the scene, many of the routine cleanup operations are accomplished by a member of the ALERT Team. This has achieved two things: first, the roadway is returned to normal operations sooner

and second, there are savings in ADOT labor costs since the level of response has been controlled to maximize their efficiency.

Since its beginning in 1986, the Arizona Department of Transportation's ALERT Team has responded to incidents of all kinds. In 1987, there were 57 incidents that they were called to. In 1990, to date there have been 108 occasions when they have responded.

The Arizona Department of Transportation considers an effective transportation system an essential quality of life feature of the Phoenix metropolitan area. In order to provide such a system, ADOT has adopted a plan that will accomplish this task in a two-fold manner. First, is Arizona's aggressive

freeway construction program where some \$5 billion will be spent on the Phoenix urban system over the next 15 years. Recognizing that it would be impractical to build enough capacity to deal with peak hour demands, the second part of this plan is the implementation of a state-of-the-art Freeway Management System. The Freeway Management System will include individual subsystems which will make it one of the most comprehensive systems in the country. As an interim measure for dealing with non-recurring congestion, ADOT has implemented the ALERT Team which responds to those unique incidents that significantly impact freeway capacity. By implementing this plan, ADOT will meet the continuing demand for modern, efficient transportation facilities that will carry Phoenix through the nineties and into the 21st Century.

HIGHWAY SUBCOMMITTEE ON TRAFFIC ENGINEERING

of the Standing Committee on Highways

Urban Traffic Management in Minnesota

RICHARD STEHR

*Director, Freeway Operations in Minnesota
Minnesota Department of Transportation*

Minnesota built a successful state-of-the-art Traffic Management Program in the mid 1970's to manage traffic on I-35W. The program built credibility and expertise over the next decade but didn't see much expansion. The number of ramps metered and cameras used for surveillance grew slowly. Plans to add new corridors were scheduled concurrent with a few major projects for construction or reconstruction of freeway corridors. Most of these projects experienced substantial delays.

A change occurred in 1988 when the Minnesota Department of Transportation's (Mn/DOT's) new Commissioner Leonard Levine declared "Congestion" to be one of his top priorities. He visited a string of large urban areas and reviewed their programs. In December of 1988 he declared a one-year "Ten Point Plan" to deal with rapidly growing congestion. The ten projects had a substantial impact on congestion and on Mn/DOT's organization.

This report covers the status of three of the ten projects initiated by the Commissioner. The first, an interim capacity improvement project utilized shoulders and minor geometric improvements to

The results have been overwhelmingly successful. Traffic accidents during the peak periods have been reduced 32 percent!

create three-lane continuity on I-94 between Minneapolis and St. Paul. The second project created the nation's first area-wide Highway Advisory Radio System. The third project was a demonstration of the use of Accident Investigation Sites to reduce congestion.

I-94 Shoulder Use Project

I-94 between Minneapolis and St. Paul was constructed in the late 1960's. It contained several lane drops that reduced the roadway section from three or four lanes in several places to two lanes under and over several key bridges. An Environmental Impact Statement had been completed and widening and reconstruction was scheduled for 1994. Substantial reoccurring delay at the lane drops was causing large numbers of rear end collisions. The

interim project consisted of converting the shoulders to driving lanes in key areas to produce three-lane continuity in each direction.

Design was begun shortly after the Commissioner's announcement. Teams that included designers, FHWA, technical reviewers, traffic engineers, maintenance engineers, and program funding representatives met to establish roles and time tables and responsibilities. Key problem areas at ramps and the narrowest locations were identified. Strategies on whether to contract for project elements or to construct with maintenance forces were reviewed in the team meetings. Early designs were circulated in advance of meetings to all team members and approvals or changes communicated at the meetings.

Where substandard geometrics could not be avoided countermeasures were employed. Ramp metering and Accident Investigation Sites were added. Shoulder "bubbles" were added for stalled vehicle storage wherever possible.

Where substandard geometrics could not be avoided countermeasures were employed.

The contract was let in June and constructed over three weekends in August, nine months after project inception. The results have been overwhelmingly successful. Traffic accidents during the peak periods have been reduced 32 percent! Traffic speeds eastbound during the p.m. peak period have increased 33 percent! The press and the public continue to refer to it as one of the best ideas Mn/DOT has had. The only negative comment has been "Why didn't we do it sooner?"

The project cost just under a million dollars. The user benefits from reduced accidents and delay resulted in a project payback period of about eight months.

Highway Advisory Radio

The second project, area-wide Highway Advisory Radio (HAR), was initiated in June of 1989. Attempts to interest commercial radio stations in joint ventures with Mn/DOT to provide improved traffic information met with little success. Two critical elements being sought were frequent "real-time" traffic broadcasts during peak hours and continuous broadcasting during major incidents.

Finally, the Minneapolis Public School radio station expressed an interest in providing traffic radio service on KBEM 88.5FM, their student training station. A two-year contract was signed in August of 1989 for \$240,000/year. Since that time a full-time professional broadcaster has been working in our Traffic Management Center (TMC) during peak travel times of 6:00 a.m. to 9:00 a.m. and 3:00 p.m. to 6:30 p.m. He gives a two to three minute traffic report every ten minutes. If a major incident occurs he broadcasts continuously until the incident is cleared. Between peak periods, Mn/DOT operators in the control room can interrupt KBEM's broadcast anytime there is a major incident and broadcast until the incident is cleared.

Two critical elements being sought were frequent "real-time" traffic broadcasts during peak hours and continuous broadcasting during major incidents.

Targeting motorists on specific routes with HAR is accomplished by dynamic signs. These blue and white signs say,

**TRAFFIC RADIO
88.5 FM
WHEN FLASHING.**

Wig-wag flashers on top of the signs are activated by a radio signal from the TMC. Individual

signs or groups of signs, or all signs, can be activated. This alerts drivers upstream from an accident that serious delays lie ahead. It also tells drivers who don't regularly listen to KBEM to tune in for an emergency message that affects them directly. This system, including 27 dynamic signs, has been operational since May 1990. HAR has proven very effective in managing incidents. Prior to installing this HAR system, congestion from an incident occurring during the peak period on I-35W south of Minneapolis was impossible to clear until after the peak period had ended. Now smooth travel can be restored faster because of the effectiveness of HAR in restoring traffic. The HAR has also been extremely valuable in reducing queue buildup during major freeway closures, such as the recent visits of President Gorbachev, President Bush, and Vice President Quayle.

Stronger promotion and public education is needed and is being planned.

Accident Investigation Sites

The third area, Accident Investigation Sites (AIS) has had much dramatic success. The intent of these sites is to reduce congestion by quickly moving stalled or damaged vehicles away from traffic lanes to these locations. The locations are out of sight of the mainline traffic and have a direct phone line to the State Patrol. Motorists involved in stalls or non-injury accidents are encouraged or assisted in moving to an Accident Investigation Site by promo-

tional materials, the State Patrol, and our motorist assistance patrol called Highway Helper. Brochures have been enclosed in license renewal notices for the last year.

Despite these efforts usage of the sites remains light. In six months there were only 52 reported uses of the sites. Four of the 20 sites have had no reported use. Sites have been used twice to report crimes, 16 times for disabled vehicles, and 34 times for accident investigation usually with a trooper present.

Light usage could be due to the reluctance of drivers to leave an accident scene unless so directed by a police officer. Some usage could go unreported because the reporting system only keeps track of the use of the phone at the sites and if a trooper reports using a site to the dispatcher. Also, some sites are not conveniently located off the exit ramps, and a few are in high crime areas where motorists may be uneasy in exiting. Stronger promotion and public education is needed and is being planned.

Summary

Two demonstration projects to deal with congestion, interim capacity improvements and area-wide HAR, have proven to be tremendously successful in dealing with congestion in Minneapolis and St. Paul. Their continued use in the Twin Cities seems assured. Use of Accident Investigation Sites remains light and will be promoted more and studied further before any decisions are made for wider use of such sites.

STANDING COMMITTEE ON HIGHWAY TRAFFIC SAFETY

Effective Short-Term and Long-Term Accident Countermeasures for a National Highway Program

CALVIN ROBERTS

Engineer of Traffic and Safety

Michigan Department of Transportation

Funding for highway safety is a major issue and is at the top of my concerns. So many forces are now acting on transportation funding at the national and state levels, that I am very concerned about our ability to maintain existing highway safety program funding levels, let alone address future, and more complex, safety needs. Upgrading an aged traffic control devices infrastructure (signs, signals, and pavement markings) to accommodate an older driver population is just one example of a need which far exceeds our current ability to respond to it.

I would like to take this opportunity today to share with you a few thoughts, based on my experiences in Michigan, which I think are relevant to all of us involved in highway safety. I characterize them as the "three realities"

The Three Realities

Reality Number 1 is "THE EASY PROBLEMS ARE ALL SOLVED." This is somewhat of an overstatement; but since traffic safety became a national issue in the mid 1960's, we have witnessed tremendous accomplishments. The interstate freeway system has essentially been completed. We have standardized highway designs, recognized and addressed the importance of "forgiving" roadsides, implemented a successful national highway/rail

crossing program, and developed "high tech" traffic control systems and sophisticated computer analyses of traffic flow and accident data. You could add several more examples to this list. While we are a long way from eliminating *all* of the identified problems, further progress in these areas is largely a matter of available funds. As more money comes available, additional problems are eliminated.

While we are a long way from eliminating all of the identified problems, further progress in these areas is largely a matter of available funds.

What we are left with are very complex issues, which in many cases require much clearer definition and focus, and adoption of a much broader management approach. An example of a "problem" requiring further focus and clarification is the aging driver issue which I mentioned a few moments ago. We all agree that this is a problem, one which will obviously increase as the age and mobility needs of the general population increase.

However, thus far, about all that we have accomplished is to develop a generalized "shopping list" of highway improvements to address the "problem" based largely on perceptions and biases. Larger, brighter, and more signs? More sophisticated traffic signals? More conservative driver performance criteria on which our design standards are based? How much larger—or brighter—or more sophisticated? The answers are evasive; yet all of these actions are being promoted as "solutions" to the older driver "problem."

All such actions invariably have a cost component—in plain language, they cost money. This does not imply that we ignore new problems; just that we need to quantify the incremental benefits and costs associated with each action. What is the *quantifiable* benefit of larger sign letter sizes? Or additional, redundant signs? Or longer passing sight distances? We do not have good answers to these questions... and we need them before we can justify new, costly programs.

Secondly, the complexity of many of the traffic safety issues we face today requires that we adopt an innovative, broad management approach, involving all public and private agencies, organizations and individuals able to address some element of the problem. Looking again at the older driver, there are several issues which all contribute, to varying degrees, to the problems—and their solutions. Improved driver license testing and creative "least impact" license restrictions, improved medical diagnosis and monitoring of the physical characteristics essential to the driving task, education of older drivers as to their limitations (and development of programs to address those needs), and involvement of social and alternative transportation agencies to address the mobility needs of our senior population are a few examples of areas where the involvement of nontraditional highway safety interests are essential to the solution of the problems.

Many other highway safety issues are similarly complex—truck safety, alcohol and drug abuse, and driver education to name a few.

In Michigan, we addressed the need to coordinate our efforts through the 1987 Governor's Conference on Traffic Safety. The Conference was the culmination of months of activity and planning directed at "Designing a Safety Strategy for Michigan's Future." The 400 Conference participants included engineers, traffic safety specialists, law enforcement officials, representatives of the legislature and judiciary, researchers, educators, administrators, and other individuals interested in traffic safety.

The principal objectives of the Conference were saving lives and reducing injuries, and economic losses from motor vehicle crashes by:

- Identifying emerging problems in the interaction of people, roads, and vehicles in the 1990s;
- Increasing understanding and cooperation between interacting public and private participants in traffic safety matters;
- Strengthening the relationship between the elements of the governmental traffic safety community; and
- Enhancing the quality and utility of traffic safety data for policy decision making.

Seven task forces were established to identify the issues and develop recommendations for Conference action. The seven task forces included: a) Enforcement and Adjudication; b) Operators, Passengers, Pedestrians; c) Recreational Vehicles; d) Research, Evaluation, Analysis; e) Roads; f) Traffic Safety Coordination and Communication; and g) Vehicles.

Conference participants developed 198 recommendations which covered a wide range of traffic safety related issues. They included legislative initiatives dealing with occupant restraints, impaired driving and walking, trucks, off road and low profile vehicles, enforcement, and traffic control. Also developed were recommendations directed at data management, public education and marketing (in-

cluding driver education), roadway safety improvements, driver testing and licensing, and research needs.

The Conference participants recognized the need to coordinate the input and efforts of the many diverse interests represented, to facilitate further resolution of traffic safety problems which remain to be solved. The approach was successful in Michigan; and I believe that the formation of these kinds of coalitions are essential to the solution of today's and tomorrow's complex highway safety issues.

The second reality is that our current data base is inadequate. Certainly, we have shown an ability to generate enormous volumes of data; and I would agree that it has greatly assisted our efforts to identify and solve traffic safety problems. However, there are tremendous gaps in our knowledge base. We know, for example, very little about the relationship of truck size, weight, trailer configuration, loading and safety. In Michigan, our Department of State Police tells us that we cannot expect them to complete accident report forms to the level of detail required to generate this data. I tend to agree that they have more important priorities at the scene of an accident, although Michigan has initiated a long-term comprehensive review of our entire accident reporting system.

We lack good, objective data to support upgrading of signs, signals, and pavement markings. At what point is it more cost effective to replace, rather than maintain our infrastructure? This requires accurate service life and maintenance cost data as well as definition of objective user benefits associated with new equipment and materials. There

is a lot of research and information "out there". To a large degree, however, it is conflicting and not based on sound, accepted, objective criteria. We need to do much, much better in the development of the basic data on which we (should) develop our programs.

The third reality is that there will be no dramatic funding increases in the foreseeable future. Events of the past several weeks confirm that transportation safety interests will have to be more vigilant and aggressive to maintain a priority and level of support which took us 25 years to achieve—and there is no guarantee that we will be successful.

So where does this leave us? I would say right back to "realities" one and two. We need to define different, more creative ways to solve problems through development of coalitions and we need to improve our data bases and more accurately focus our programs on the *highest priority* problems and the *most cost effective* solutions to those problems. In Michigan, we have a phrase which captures the essence of this approach "Do more with less".

Vision for The Future

My vision for the future: We will not be allocated more money to solve our future problems, some of which I have identified today. We must increasingly rely on each other and on organizations and individuals not previously considered in the "mainstream" of our operations. We need to more fully access and utilize data processing technology and quality research to manage our programs.

To do otherwise is to fail.

STANDING COMMITTEE ON PLANNING

National Traffic Monitoring Standards: Current Progress and the Potential Role of AASHTO

DAVID ALBRIGHT

Chief, Research Bureau

New Mexico State Highway and Transportation Department

The most wide-ranging crisis confronting the transportation profession is a quiet crisis in the quality of our nation's traffic data. It is a wide-ranging crisis because traffic summary statistics affect virtually every aspect of transportation planning and engineering. The appropriateness of geometric design, pavement design, accident exposure assessment, and intersection analysis is founded on monitoring vehicle volume, classification and weight. The precise assessment of vehicle demand impacts the competitiveness of our transportation system. The crisis in traffic data is quiet because there is a common and mistaken impression that our states' traffic data are equivalent and adequate.

The precise assessment of vehicle demand impacts the competitiveness of our transportation system.

During the 1990 AASHTO Annual Meeting the foundation will hopefully be built to address this crisis. It is my hope that the American Association of State Highway and Transportation Officials (AASHTO), through the Standing Committee on Planning, will begin the process of defining national standards of traffic monitoring practice.

The potential role of AASHTO is to clarify traffic issues specifically of concern to state highway and transportation agencies, and to define uniform traffic monitoring procedures. The intent of the proposed AASHTO traffic monitoring standards is ensure that state traffic monitoring procedures are informed by a document identifying standard traffic data collection, summarization and reporting. No such standard reference now exists.

The potential role of AASHTO is to clarify traffic issues specifically of concern to state highway and transportation agencies, and to define uniform traffic monitoring procedures.

AASHTO traffic monitoring standards would provide a common reference by which states could assess, and if appropriate revise, their current procedures. Within the proposed standards a consistent procedure would be identified by which states could document the differences between their practice and the standards. Standard practice combined with consistent notation of exceptions to standard practice would provide comparable, or if exceptions at least understandable, traffic data from

site-to-site, city-to-city, state-to-state, throughout the nation.

One critical individual decision in summarization of the data collected is the computational method for deriving traffic summary statistics.

In urging the development of AASHTO traffic monitoring standards, this presentation is in three sections. First, I will briefly outline the state-of-the-practice and general implications of non-standard practice. Second, I will trace recent events which have focused attention on the importance of standards. Third, I will identify foundational standards, as well as obstacles which will be experienced if AASHTO proceeds in the development of national standards.

The State-of-the-Practice

To the extent that there is today common traffic monitoring practice among the states, it has been defined by federal traffic reporting requirements. Uniform samples of traffic have been recommended to help ensure that national traffic reports represent comparable data, and that construction projects utilizing federal funding share common and identified traffic characteristics.

The emphasis of federal highway traffic reporting is on system level estimates. This is reflected in the design of the Highway Performance Monitoring System and in the Federal Highway Administration publication of the *Traffic Monitoring Guide* in 1985. (1,2)

The federal government has identified summary statistics to be reported which represent traffic volume, vehicle classification, and equivalent weight by vehicle classification. This set of summary statistics for understanding traffic includes generally accepted naming conventions. Examples include

the convention for naming the mean daily traffic volume, a federal vehicle classification typology, and a definition of equivalent axle loads.

Beyond these positive contributions from the federal government, traffic monitoring decisions are currently based on individual judgment. The highway traffic monitoring profession in the United States developed with an emphasis on individual rather than standard practice. The state-of-the-practice in traffic monitoring is based upon individual decisions within offices, agencies and states.

Individual decisions result in diverse data collection activities. Data collection decisions include the number, period and location of measurements for site specific traffic monitoring, and the type and placement of traffic measuring devices.

The individual basis of traffic monitoring decisions has also resulted in diverse data summarization procedures. One critical individual decision in summarization of the data collected is the computational method for deriving traffic summary statistics. A second critical summarization decision is whether or not to permit imputation missing data from traffic measurements. If permitted, individual decision-making includes the imputation procedure to estimate missing measurements.

In many state agencies professional judgment is also involved in determining how to estimate the same conventionally named traffic summary statistics in the absence of any site specific traffic measurements. Because there is now no format for disclosure of these individual decisions, administrators and traffic data users may or may not be aware of this practice, the extent of the practice, and the errors which may be introduced by the practice.

What are the implications of the state-of-the-practice in traffic monitoring? One concern is that individual decisions about traffic data collection and summarization are commonly made without awareness of alternatives, and the implication of these decisions. There needs to be a common reference for the appropriate exercise of individual decisions.

The absence of standards opens what should be a technically-based process to political pressure and expedience. Without a standard practice to which planners and engineers can refer, it is sometimes difficult for traffic professionals to restrain demands to modify or manufacture traffic data.

A final, general consequence of the absence of standards, with its attendant costs to developing the nation's transportation system, is the inability to address basic traffic statistical issues. What is the variability around the mean statistic for a given traffic characteristic, by monitoring method? What are the appropriate statistics to indicate the central tendency of traffic data? What is the appropriate reliability factor or factors to use in the AASHTO pavement design equations? What is the impact of error in historical traffic data on national pavement and structures research? Standardized data would permit systematic examination of traffic monitoring.

One concern is that individual decisions about traffic data collection and summarization are commonly made without awareness of alternatives, and the implication of these decisions.

The current individual practice in traffic monitoring has resulted in data which appear to be comparable because they carry the same labels, such as Average Daily Traffic. However, disparate practice within and among agencies means the data may or may not be directly comparable. Individual practice in the absence of standards has resulted in a process which is susceptible to technically inappropriate traffic statistics because of politics and the pressure of expediency. Individual practice has resulted in a traffic monitoring process which produces statistics without the ability to determine the confidence with which the statistics may be used.

Progress Toward Standards

There is a recent and growing awareness of the need for standard practice. While this awareness may be traced back to the impact of the *Traffic Monitoring Guide* published in 1985, the current activities toward standard practice include: the Strategic Highway Research Program (SHRP) Traffic Data Collection and Analysis Expert Task Group of the Long-Term Pavement Performance Advisory Committee; the American Society for Testing and Materials (ASTM) E17.42.89.1 Task Group on Vehicle and Configuration Sensing; and, the Institute of Transportation Engineers (ITE) Committee SP-7, on Traffic Counting Practices. I will share these activities, and how AASHTO's proposed standardization effort might inform and be informed by these efforts.

SHRP has been a catalyst for traffic monitoring standards. Quality of traffic data in the absence of standard practice was defined as a national concern when the Long-Term Pavement Performance portion of SHRP began development of a National Pavement Database.

The original SHRP database design called for a single, simple set of traffic summary statistics for annual and cumulative axle load distribution. In the absence of standard practice, it quickly became apparent that the way in which states collected and summarized vehicle data would result in broadly mixed data. These mixed traffic data jeopardized the research program. This realization led to SHRP development of a National Traffic Database to provide consistent summarization of base data, and descriptive labels as to the different quality and quantity of data collection underlying the summary statistics. While SHRP did not establish traffic monitoring standards, the foundational principles for national standards were forged by SHRP from 1988 to the present.

In July 1990, in response to the issues raised by SHRP, ASTM began the process of defining traffic monitoring standards. The first ballot for draft traffic standards was completed in October 1990. The results were thirteen affirmative, three negative,

and seven abstentions. The second ballot should be issued in December 1990. There is a possibility that within two years ASTM will have defined standards.

To provide equivalent and comparable summary statistics, there must be a consistent method of computing the summary statistics.

The ASTM standards will be those basic standards which are responsive to the needs of cities of all populations, counties, regional authorities, and the private sector. Some portions of the ASTM standards will be related to state agencies. For state transportation agency purposes, however, the draft ASTM standards are limited in several ways. Significant limitations are the few states which review of the balloted standards, and the necessary absence of reporting requirements and data concerns unique to state agencies. AASHTO is proposed as the appropriate organization to address and implement standards of practice for state agencies. If adopted, the AASHTO process would be well served by establishing clear communication with the important, related, and independent activities of SHRP and ASTM.

ITE has established a committee on traffic practice. A national survey will be conducted of current practices. This survey may assist in documenting the current breadth of individual practices in the nation, and the magnitude of change which standards would bring.

These are the current standard efforts from which AASHTO would benefit. If AASHTO were to initiate standards, this process in turn would benefit SHRP, ASTM, ITE, and all traffic data users. Given this context of current activity, if AASHTO standards were initiated what would be the direction taken, and what obstacles might be expected?

Foundational Standards and Obstacles

As AASHTO considers initiating traffic monitoring standards, it is appropriate to identify both potential foundational principles and obstacles. In the process of developing the National Traffic Database, three fundamental principles of standard practice were defined by SHRP. These fundamental principles are recommended as the beginning point for AASHTO's proposed work in standards development.

To provide useful reports, traffic monitoring standards must incorporate the Principle of Truth-in-Data. Persons receiving traffic data reports need additional information to make traffic summary statistics meaningful. The minimum requirement for traffic monitoring standards was adopted for site specific summary statistics by the Strategic Highway Research Program (SHRP). The SHRP requirement is that a description of the period and type of traffic measurement must be provided for each reported traffic summary statistic.

The traffic data obsolescence problem in national and state databases today is significant but not quantifiable.

To measure traffic for equivalent summary statistic calculation, there must be adherence to the Principle of Base Data Integrity. Missing or inaccurate raw data may not be completed, filled-in, or replaced for any type of traffic measurement, at any location, under any circumstance. What is inviolable is the distinction between a measurement and an estimated value.

To provide equivalent and comparable summary statistics, there must be a consistent method of computing the summary statistics. There is also a recognition that as standard data become available, the traffic monitoring profession will learn. Alternative summarization procedures will be defined. The recognition to be consistent in computation

now, and open to new computational approaches in the future, is the Principle of Consistent Computation in a Dynamic Field. The third principle is also the basis for data retention for alternative statistic computation and comparison. This is particularly important in research activities involving traffic data.

Data obsolescence is a problem which, finally, can only be addressed through standard practice.

These foundational principles are an important contribution of SHRP to the traffic monitoring profession. They point the way to widespread, standard measurements underlying summary statistics.

What are the obstacles that will be experienced if AASHTO proceeds in developing traffic monitoring standards? First, because there are highly diverse traffic monitoring practices, virtually all state programs will experience change. That change will take time. Fortunately, the Truth-In-Data principle has the potential to preserve data integrity during the transition years.

Second, the very individualistic nature of the profession will require that persons perceive that traffic data are property in the public trust, rather than the domain of an individual or an office. Misrepresentation of traffic data, however politically pressured or expedient, if only because of the highway safety implications of such practice, must be considered to be a violation of the public trust. The Principle of Base Data Integrity addresses this obstacle in part. There may be expected to be some state agencies in which individual professionals perceive a vested interest in maintaining traffic data as their personal domain.

Third, in addition to traffic monitoring changes developing state-by-state over a period of years, there will be discontinuities in traffic databases.

When there is a change in procedure to standard practice, the data collected and summarized under standards will be different than the years of historical data either estimated or factored to appear reasonable and to appear to have continuity. The traffic data obsolescence problem in national and state databases today is significant but not quantifiable. Under standard practice, agencies will be able to begin to quantify the extent to which their historical data are obsolete. After standards, the reality of traffic data obsolescence will create pressure within the state agency to address obsolescence by counting more road segments under common practice. This will be a concern particularly on higher functionally classified roads.

This problem will not occur as a result of traffic monitoring standards. Traffic data obsolescence is an existing national problem which will become apparent under standard practice. Data obsolescence is a problem which, finally, can only be addressed through standard practice.

Recommendation

It is recommended that AASHTO, through the Standing Committee on Planning, establish a working group on national traffic monitoring standards. Such an effort should be characterized by clear communication with other traffic standards activities and interests, and specifically building upon the three foundational principles established by SHRP.

Summary

There is a need to monitor traffic volume, vehicle type, and load in a consistent and comparable manner among the state departments of transportation. The definition and implementation of standard traffic monitoring practice will require significant modification to existing practice. The alternative to standards development is unacceptable given our commitment to the safe and efficient movement of people and goods.

References

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STANDING COMMITTEE ON PLANNING

National Traffic Monitoring Standards: A Federal Perspective

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The importance of quality data of all types to support Federal and State programs has been growing significantly in the last few years. In no area, however, has the demand grown faster than in the area of better, more extensive, statistically valid traffic data. For that reason, we at FHWA strongly support the AASHTO Standing Committee on Planning taking up the issue of how traffic values are derived. Continuing emphasis on issues, such as traffic data quality and uniformity, will benefit everyone involved in highway transportation.

The President's National Transportation Policy's calls for better across-the-board data on transportation demands and associated social and economic effects. Better traffic data is a basic ingredient of such information.

Figure 1 illustrates that travel is the most dynamic of the several variables we deal with in planning for highway transportation.

Figure 2 illustrates that not only does total highway travel change significantly, but that the composition of travel by vehicle type is also changing. The 1980's saw greater attention to pavement management activities and the need for better traffic data—State, National, SHRP, and LTPP. Likewise, more emphasis on Interstate travel estimate since it was used for apportioning an increasing amount of I-4R funds—\$2.5 billion for FY '92.

More recently, there has been increased emphasis by FHWA and others on measuring urban congestion. Figure 3 shows what has happened on Urban Interstate and Other Freeways in recent years.

Air quality issues will add their own momentum to better travel monitoring.

As a result of this environment, the FHWA has made several major changes to the structure of traffic data collection, and more changes are anticipated as we strive to develop more objective and flexible systems. Over the next several minutes, I want to discuss some of those changes.

The so-called information age, coupled with significant advances of electronic technology, have facilitated major changes in the way in which we collect and assimilate traffic data.

In the not too distant past, traffic data were collected subjectively, based on individual judgement or the policy "*that's the way we have always done it.*" Data collection was often somewhat primitive without a clear plan, and was usually a manual labor-intensive operation. The goals usually emphasized quantity over quality or statistical significance. I fear that, even today, these situations sometimes still exist.

Figure 1. Highway Indicators (1968-1988)

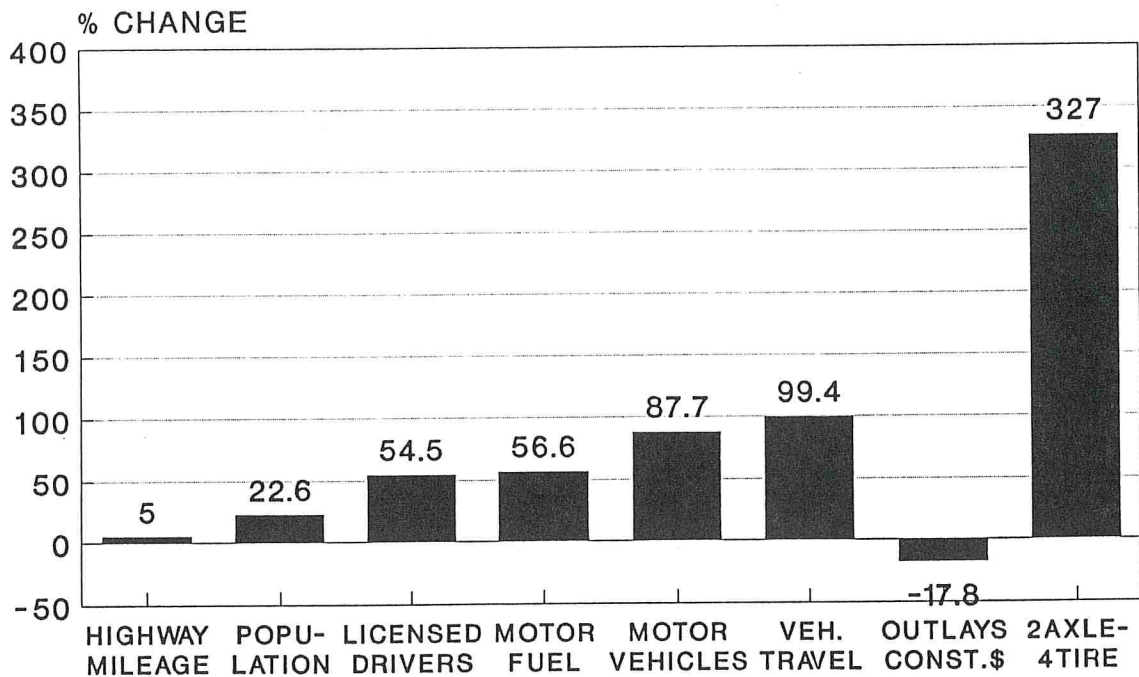


Figure 2. Travel Changes (1968-1988)

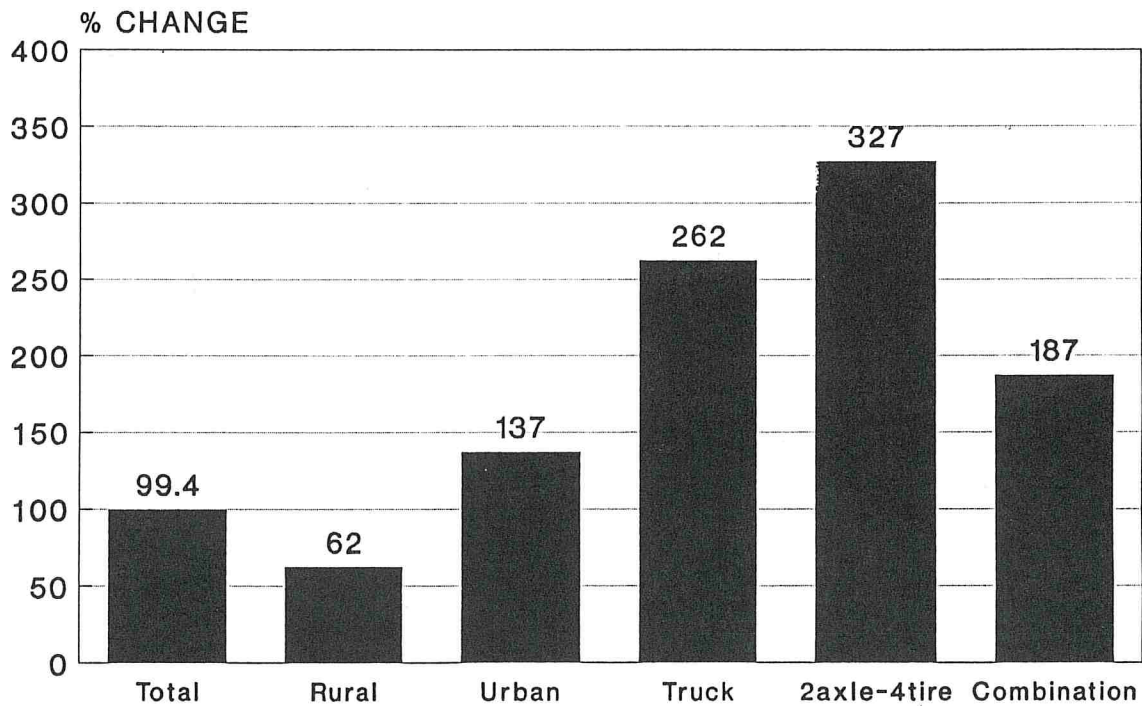
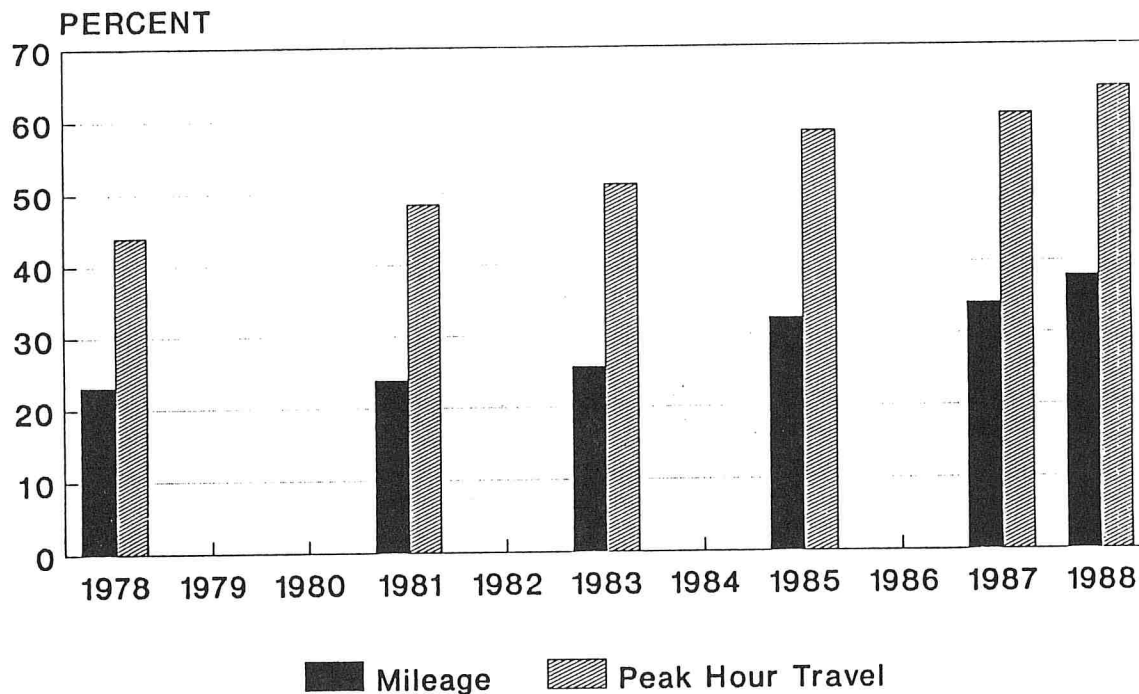


Figure 3. Percent with $V/SF \geq 0.8$ Urban Interstate and Freeways



Presently and in the future, I believe that the collection of traffic data will focus much more heavily on objective statistical procedures designed to meet the desired objective while minimizing cost. The emphasis will be on *quality rather than quantity*, although new electronic technology will probably permit gains in quantity as well at reasonable resource levels.

The greatest emphasis, however, must be placed on the *quality and reliability* of the data.

We, in FHWA, believe that the basic principles of a reliable data collection program are:

- Identify the *objectives* of the data collection program.
- Develop a *statistically based plan* to collect data meeting these objectives.

- Use reliable, cost-effective, bias-free data collection *equipment* which meet recognized standards such as those developed by ASTM.
- Introduce *process controls* to insure quality and uniformity in the conversion of raw data to information.
- Prepare *documentation* to offer users an explanation of the data processes.
- Finally, conduct *periodic evaluations* to improve and update the program.

Our experience in the development of national data collection programs may be of value in your consideration of issues that might arise in an effort to develop national traffic monitoring standards.

The implementation of the HPMS is illustrative of some of these issues. The HPMS was established in 1978 in order to provide the Secretary and the Congress with timely reporting on the performance and conditions of the Nation's highways.

Management of the HPMS has required regular training of FHWA field staff and State personnel. Further, FHWA performs internal reviews of the quality of both the data and the oversight provided by its various organizational elements, including periodic reviews by State personnel of FHWA's management of the HPMS.

We at FHWA consider the HPMS one of our major success stories. Thanks to the concerted effort of hundreds of persons in the States and FHWA, as well as the willingness of the States to devote the other supportive resources to the HPMS, we have improved the quality of information provided to Congress at a reduced cost.

As a result of our monitoring of the HPMS process, by 1983, FHWA became increasingly aware of the need to provide some direction on uniform procedures to be used in the collection of traffic data. Most of the material that existed then was based on the work of Boris Petroff in the 1950's and 1960's. This led to the 1985 issuance of the "*Traffic Monitoring Guide*" (TMG).

The TMG's objective is to provide at least a minimum degree of national uniformity of traffic data collection to support the HPMS traffic data reporting.

To reach the objective, TMG emphasized the integration of traffic data programs, the maximum use of automated data collection equipment and the development of a statistical data process.

The TMG was released as a guide, not a requirement, leaving States free to develop alternative statistically based procedures. Since the TMG was first published, we have seen major improvements in traffic programs.

As with the HPMS, providing leadership in implementation of the TMG approach has required extensive oversight and training by FHWA as well as a willingness by the States to make the necessary resource commitments implicit in the TMG approach.

Both the HPMS and the TMG are living documents—they will be supplemented or updated as needed to remain current and to be responsive to emerging issues.

Part of FHWA's effort to insure data quality has been the implementation of an annual field review process.

This review was originally initiated to support the I-4R apportionment process. Although the last I-4R apportionment has been made, there is a continuing need for such reviews. As I will discuss later, there are too many traffic based issues facing us nationally and, as a result, there will probably be increased rather than decreased emphasis on high quality traffic data in the future.

The field review process requires each FHWA field office to verify the AADT and VMT figures reported to the HPMS. The review consists of following the AADT development of a small sample of sections, comparing the HPMS reported sections located at ATR stations vs. the data from the ATR itself, comparing State boundaries, and examining VMT growth trends.

The review process is another example of the quality management concept and insures FHWA confidence that apportionment is equitable and follows the legislative requirements.

My use of the term "traffic" in this presentation is intended to encompass collection of traffic volume data, vehicle classification data and truck weight data. Traffic based issues increasingly cut across all three types of traffic data and any data collection process should support each of them.

1. The Continuous ATR data reporting system.

- At present, data is reported to FHWA by the States monthly.
- We are weighing the idea of accessing (where States are agreeable) a national sample via telemetry.
- Any data collection standards must recognize the increasing need to move traffic data nearer to being real-time. This situation exists not only to be more responsive to highway program administrators, but also because of the need to provide data to be used in various IVHS initiatives.

2. The Vehicle Classification data reporting system.

- In the past, vehicle classification data is reported to FHWA only in combination with truck weight data.
- VMT, classified by vehicle type, is presently reported to the HPMS as an areawide form.
- In the future, we plan to institute a full classification data reporting system compatible with the TMG guidelines.
- Reporting of vehicle classification data is one of the areas of greatest need and would allow direct tying of vehicle type data to traffic volume and truck weight data in support of pavement management, accident analysis, and policy development.
- In recognition of this ever expanding need and the fact that vehicle classification counts are not much more expensive than simple counts of total traffic, a number of States have moved to extensive classification count programs.

3. The Truck Weight data reporting system.

- The collection of weight data is a good example of the measurement method directly affecting the reliability of what is measured.
- Static weighing has been shown to result in data that does not typify the traffic stream. As a result, it is FHWA policy to accept only WIM data for the Truck Weight Study.
- Any national traffic data collection standards will need to consider how the data is to be collected and how the method of collection may impact what is measured.

In summary, FHWA and DOT have made a major commitment to improving the quality of traffic data.

We continue to see in the horizon increasing need for more and more reliable traffic information to address major national problems. Not just for the FHWA, but for States and local governments, other Federal agencies, national organizations such as AASHTO, SHRP, TRB, etc.

What are some of these evolving issues which will necessitate better traffic data?

- Advocacy by some highway groups of its expanded use in fund apportionment.
- More focused attention on identifying, quantifying, and monitoring urban congestion.
- Better travel data by vehicle type for assessing traffic safety (exposure data). The recently released TRB Special Report 228 on "*Data Requirements for Monitoring Truck Safety*" deals extensively with current truck travel data shortcomings and recommends major new emphasis on truck exposure data quality building on the current HPMS/TMG systems.

- Closely related to urban congestion is the issue of air quality and how transportation affects it.
- The whole evolving arena of IVHS and the real time traffic data needed to make it work.
- Expanded efforts in truck weight enforcement.
- Cost-allocation revised.
- Economic issues such as international competition, economic revitalization, revenue forecasting, etc.

In response to at least some of these issues, it is likely that the Administration's highway reauthorization legislation proposal will require four management systems—bridge, pavement, safety, and congestion—to serve as a base for decisionmaking by the States. High quality traffic data would be essential to each of these systems.

The preceding issues are felt to be of such a significance by various groups that there is also support within U.S. DOT to call for uniformly monitored statistically based sampling through legislation or regulation.

FHWA's efforts for increases in quality will continue. Likewise, we will continue to support the use of new technology to work smarter and in more cost-effective terms.

STANDING COMMITTEE ON PLANNING

The Need for National Highway Traffic Monitoring Standards: Idaho's Experience

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The Idaho Transportation Department began a study of traffic survey procedures in 1986 with the intent of implementing the FHWA *Traffic Monitoring Guide* (TMG). Considerable research was done to review all aspects of traffic data collection and analysis: equipment, sample sizes and locations, Highway Performance Monitoring System (HPMS) and Strategic Highway Research Program (SHRP) requirements, special needs, vehicle classifications, truck weights, communications, software, data storage and retrieval, data analysis, etc. The research was helpful in selecting sample sizes and locations and improving data collection practices, but it also revealed many problems in traffic data collection and analysis. When we checked with other states we found that we were not alone; other states had similar problems or didn't know a problem existed.

This morning I will discuss Idaho's traffic monitoring program, problems encountered, and need for standards. I believe this is essential if our goal is to obtain consistent and uniform traffic data at the local, state and national levels.

Traffic Survey Plan

A Traffic Survey Plan for collecting traffic volumes, vehicle classifications and truck weights for 1990-92 is completed. The volume samples are being collected at Idaho's HPMS sites. The vehicle classification samples are being drawn at random

from the volume samples, and truck weight samples are being drawn from the vehicle classification samples. A number of additional sample sites have been identified to satisfy state needs for project level data. The three-year sample plan was designed to meet both state needs for project estimates and system needs as specified in the *Traffic Monitoring Guide*.

In the development of the traffic survey plan, we researched available literature, examined statistical models, studied the data base, talked to other states, and pulled our hair out. The *Traffic Monitoring Guide* provided guidance, especially from the national perspective, but it was of little value at the state level. It took a major effort to address state needs for pavement management, highway needs, and project level data. Standard procedures for developing a complete traffic monitoring program for the state would have been very helpful.

Statistical Objectives

The statistical objectives are expressed as statements of target precision for systems estimates for the three-year cycle. Precision for intermediate years are interpolated. All truck-weight measurements for projects in the special needs element include vehicle classification and volume counts at the project location. This facilitates collating project truck-weight measurements with those made at randomly selected HPMS sections in order to compute rough

estimates of load distribution factors (ESALS per vehicle) and vehicle classifications for truck loadings by functional class and statewide for selected axle combinations. As we obtain more vehicle classification data in the future the equivalent single axle loads (ESALS) will be stratified by vehicle mix rather than functional classification. They can be aggregated by functional classification later.

In Idaho, the 1987 HPMS sample serves as the universe for all data collection proposed for implementation of the *Traffic Monitoring Guide*. The Department has initiated a sampling plan for traffic volumes, vehicle classifications, and truck weights. It includes the year and sample sizes for continuous and short-term counts.

Idaho has 100 Automatic Traffic Recorders (ATRs) permanently installed throughout the state, of which 30 are in the urban area, mostly for screenline counts. For the most part the ATR sites were strategically located at locations that had different seasonal patterns. The seasonal patterns were determined by setting temporary control stations for a full week each quarter. When other seasonal patterns were identified another ATR was installed. We were restricted to those locations that had easy access to utility services.

The automatic traffic recorders are grouped into patterns that exhibit similar variations. These are used to assign traffic patterns to other highways with similar seasonal and traffic characteristics. Seasonal adjustment factors are used to expand short-term portable traffic counts to annual average daily traffic.

Because of the variations in weather patterns and special traffic conditions from year to year, a five-year average weekday for each month, omitting holidays, is computed for each automatic traffic recorder that has operated 75 percent of the year. Seasonal adjustment factors and the coefficient of variation are computed for the average weekday for each month.

The automatic traffic recorders are sorted by their coefficient of variation and the seasonal varia-

tion factors are plotted on separate graphs. The graphs are grouped together by comparing the monthly fluctuations of each graph. Sorting the automatic traffic recorders by the coefficient of variation reduces the time required to group them.

The monthly group mean averages, together with their standard deviations and coefficients of variation, are calculated with a SAS program. Monthly factors are analyzed and the percent precision is calculated for each group. The estimated precision is used to determine the number of automatic traffic recorders required to attain ± 10 percent for 95 percent of the time.

The *Traffic Monitoring Guide* recommends that seasonal adjustment factors for automatic traffic recorders be stratified by functional classification. When we stratified by functional classification we found the precision was acceptable for the Interstate and Principal Arterials, both rural and urban, but it did not hold true for Minor Arterials, Major Collectors, and Minor Collectors.

Within each of the functional classifications, there were one to seven groups stratified by seasonal variation factors. If we were to group by functional classification we would be losing some statistical accuracy or we would have to increase the seasonal adjustment groups, thereby causing considerable redundancy.

The *Traffic Monitoring Guide* also suggests that cluster analysis be used to determine groups by seasonal adjustment factors. We found the groups were too general and required further manual adjustments. Standards for statistics would help the state develop consistent and rational state, national, and project level traffic data.

Calculation of Axle Correction Factors

Axle correction factors are required for traffic recording equipment that uses one pneumatic road tube in the counting operation. Unlike a vehicle loop detector, which gives one count each time a vehicle passes over the loop, regardless of size or combination, a road tube requires two hits to pro-

duce one vehicle count. Multi-axle vehicles cause overcounts. A five-axle truck will produce two and one-half vehicles; therefore, axle correction factors are needed to adjust the axle overcounts to vehicle counts.

Correction factors are developed from vehicle classification counts. The number of axles are multiplied by the number of observations of each vehicle type. The total number of axles are then summed and divided by two. This gives the total of two-axle vehicles. A correction factor is calculated by dividing the total number of vehicles observed by the total two-axle vehicles. These factors are averaged by the functional classification system. Some functional classes have more than one axle correction factor assigned to it.

We have developed new vehicle data recording equipment that records the date, time, speed, number of axles, and the axle spacings of each vehicle. The data is binned by an office microcomputer at the present time. Work is underway to bin the data in the field. The equipment is not limited to classifying vehicles into predetermined groups of axle configurations, such as the FHWA 13 categories (Scheme F); it bins vehicles by any axle configuration it finds in the traffic stream. New bins are added automatically as new axle configurations are identified in the traffic stream. The axle correction factors are calculated on a forty-eight hour sample at each vehicle classification site.

In these several activities of collecting axle counts, developing axle correction factors, summarizing and binning data, and applying them to roadway segments, I see a real need for standards.

Data Analysis

Portable traffic count data, vehicle classification data, and truck weight data are submitted on 3 1/2" floppy disks to the Boise office. The data is edited on PC computers before being transferred to the main frame for development of reports and storage. Vehicle classification and truck weight data are converted to 171 byte records. The formats are the same for all axle spacings. During the conversion of

the vehicle classification and truck-weight data, a ten-digit axle configuration code is added for vehicle identification and a three digit edit code is added to identify questionable data. All raw data is stored on tape files. A new standard is needed to replace the FHWA two-card format, which requires additional sorts to analyze individual vehicle types.

Portable hourly traffic counts are summarized to an average 24-hour day and stored in a file that includes the site location, date, 24-hour data, axle overcount factors, seasonal adjustment factors, type of device used to collect the data, and a three-digit edit code. The vehicle classification data is summarized and stored in the same file, but without an axle-overcount factor. Each record is adjusted to an estimate of average annual daily traffic based on the appropriate axle overcount factor and seasonal adjustment factor. This record becomes the historical record from which growth factors are developed and are available for access by other users.

All data are used in the development of the permanent traffic volume and commercial volume file. This file is used for roadway design, planning, maintenance, HPMS, and other uses.

Machine errors are computed by manual classifications with portable counters. Each manual classification consists of observing up to 50 vehicles by the number of axles they have on the ground. The number of vehicles observed times the number of axles divided by two should equal the total vehicles on the counter;

Need for Standards

There is a need for standards in the many activities of traffic monitoring. Standards are needed for equipment, data collection, binning and grouping data, statistics, data analysis, distributing counts over the highways, obtaining project specific data, and developing traffic monitoring plans. I believe the implementation of the federally mandated Highway Performance Monitoring System has set the stage for developing standards for traffic monitoring. Uniform procedures are needed if we are to have consistent national data. When comparing

traffic data between bordering states, counties, cities, and federal agencies, it is important that we have data that is collected and analyzed by the same standards.

I have just described Idaho's procedures. Other states use different methods. Since there are no uniform guidelines, traffic data at the borders between states are not comparable. City, County and Federal traffic data cannot be correlated with state data. I believe the time has come for traffic monitoring standards that can be used by all entities.

STANDING COMMITTEE ON PLANNING

Transportation Provisions of the Clean Air Act Amendments of 1990

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On November 15, 1990, the President signed the Clean Air Act Amendments (CAAAAs) of 1990 into law. The new CAAAs will substantially revise the Federal-aid highway program in ozone and carbon monoxide (CO) nonattainment areas due to its provisions for highway sanctions; the conformity of transportation plans, programs, and projects; the transportation and air quality planning processes, vehicle-miles-traveled (VMT) forecasting procedures; and other transportation and air quality provisions.

The Transportation community faces challenging times ahead in meeting our mobility needs and for improving our air quality. The CAAAs of 1990 will add to these challenges and significantly alter the process for developing transportation plans, programs, and projects, because they place heavy emphasis on controlling VMT and congestion levels. The major impact from these provisions will be to shift a greater responsibility to the transportation community for improving air quality in nonattainment areas. This in turn will require greater emphasis on demand management strategies and operational improvements to the existing transportation infrastructure in air quality nonattainment areas.

The purpose of this paper is to provide an overview of the key transportation-related provisions in the CAAAs of 1990.

Transportation-Related Provision

Oxygenated Fuels

The CAAAs of 1990 require the sale of oxygenated fuels, with at least a 2.7 percent oxygen content by weight, in the 41 CO nonattainment areas in order to lower their CO concentrations levels. It also requires a 2.0 percent oxygen fuel content for the 9 most severe ozone nonattainment areas. These provisions will encourage the use of oxygenated-containing additives like ethanol and methyl tertiary butyl ether, a natural gas derivative.

These provisions could result in some additional losses to the Highway Trust Fund (HTF) since gasohol (10% ethanol, 90% gasoline) is exempt from 6 of the 9.1 cents per gallon highway user fee. This exemption will be reduced to 5.4 cents per gallon under the budget reconciliation bill, starting December 1, 1990.

In recent years, the HTF has lost an estimated \$480 million annually due to the voluntary use of gasohol. Additional losses to the HTF from the use of a 2.7 percent oxygen content will depend on the extent to which gasohol is used to meet this requirement. Fortunately, other alternative fuel sources can compete with gasohol to meet the 2.7 percent oxygen requirement.

Highway Funding Sanctions

Under the new law there are basically two mandatory sanctions. They are the withholding of approval of Federal-aid highway projects, and a two-for-one emissions offset for new or modified stationary sources. Areas where sanctions are proposed have 18 months from the finding or disapproval that requires sanctions, to correct the deficiency before sanctions take effect. Only one of the sanctions will be imposed initially, unless the Environmental Protection Agency (EPA) determines that there is a lack of good faith, with the other one being mandatory if the deficiency is not corrected within 6 months after the first sanction is imposed.

The sanctions may be applied to any portion of the State that the EPA determines reasonable and appropriate, with the condition that they cannot be applied on a statewide basis for the 24-month period following imposition when one or more political subdivisions covered by the State Implementation Plan (SIP) is principally responsible for the action or inaction resulting in sanctions. The sanctions may be applied for these reasons: 1) failure to submit a SIP or a portion thereof; 2) EPA disapproval of a SIP; 3) failure to make "any" submission required by the Act, including VMT and congestion level data; and 4) failure to implement "any" SIP requirement.

The preceding provision expands the application of highway sanctions beyond that of the 1977 CAAAs in several ways. First, sanctions could only be applied to the nonattainment area under the 1977 amendments. Secondly, there was a connection between the availability of highway sanctions and transportation generated pollution because one of the conditions for the imposition of the sanctions was a determination that transportation control measures (TCMs) were needed to attain the standards. Finally, highway sanctions were available under the 1977 amendments for basically one reason, which was failure to submit or make reasonable efforts to submit a SIP.

Under the CAAAs, once highway sanctions are imposed, the Department of Transportation (DOT)

may exempt grants for safety projects, but only when it is determined that the primary purpose of the project is to solve a demonstrated safety problem and is likely to result in a significant reduction in, or avoidance of, accidents. In addition to safety, exemptions may be granted by DOT for a list of seven specific project types as follows: 1) capital programs for public transit; 2) construction or restriction of bus or high-occupancy vehicle (HOV) roads or lanes; 3) planning to reduce employee work-trip-related vehicle emissions; 4) traffic flow improvements which achieve a net emission reduction such as ramp metering and signalization projects; 5) fringe parking facilities; 6) programs to limit downtown vehicle use or in other areas through tolls, parking surcharges, or other pricing mechanisms or restrictions; and 7) programs for accident management to reduce congestion and emissions. Finally, transportation-related programs that EPA, in consultation with DOT, determines would improve air quality and would not encourage single occupancy vehicle capacity may be exempted.

The 1977 amendments provided DOT the authority to exempt safety, mass transit, or transportation projects related to air quality improvement or maintenance. The CAAAs of 1990 are more specific and there is more emphasis on encouraging the development and implementation of projects that move people while discouraging capacity increases for single occupancy vehicles.

Conformity

The 1970 Highway Act added Section 109(j) to Title 23 of the United States Code. This section required the Secretary of Transportation, after consultation with EPA, to promulgate guidelines to ensure that highways constructed pursuant to Title 23 were *consistent* with any approved SIP. As a result of this provision, the Federal Highway Administration (FHWA) issued regulations on November 14, 1973. The regulations required extensive analytical justification of all transportation plans, programs, and projects. This process had little relationship to the SIPs being developed, and experience indicates that project-level analyses were

not meaningful in resolving air quality problems, except for CO hotspots.

The 1977 CAAAs added, among others, Section 176(c) to the Clean Air Act. This section makes it the affirmative responsibility of the Federal agency supporting an action to ensure that its activities *conform* to an approved or promulgated implementation plan. It also prohibits the metropolitan planning organization (MPO) from approving any plan, program, or project which does not conform to such a plan. Section 174 of the 1977 amendments also required greater integration of the transportation and air quality planning processes. This shifted the emphasis for resolving air quality problems to the transportation system planning and SIP development processes where regional air quality strategies could be more effectively analyzed. As a result of these provisions, DOT and EPA developed a conformity agreement, dated June 12, 1980. The FHWA and the Urban Mass Transportation Administration subsequently promulgated a conformity regulation, based on this agreement, on January 26, 1981.

The conformity provisions of the new CAAAs shift the emphasis from conforming to a SIP, to conforming to a SIP's "purpose" of eliminating and reducing the severity and number of violations of the national ambient air quality standards (NAAQS) and achieving expeditious attainment of the standards. This provision places a greater burden on the transportation program by shifting the conformity process from a plan comparison during the system planning process, back to an analytical process during the development of plans, programs, and projects. It will also significantly increase the contributions that transportation plans, programs, and projects must make toward air quality improvements in nonattainment areas.

The new provisions still require the DOT and MPOs to make conformity determinations. However, the determinations will be made based on conformity criteria and procedures for transportation plans, programs, and projects which are promulgated by the EPA, with the concurrence of DOT, within 1 year of enactment. The States have to submit SIP revisions that include criteria and procedures for

determining conformity to the EPA and the DOT, within 2 years of enactment.

The process recognizes that transportation-related air quality issues must be analyzed on a system-wide basis and be controlled through regional strategies in order to be effective. Consequently, projects contained in transportation plans and programs should be analyzed in the aggregate, rather than individually where assessment of regional impacts cannot be measured with any degree of accuracy. This process will not require each project in the transportation plan and program to be analyzed individually, rather it requires transportation plans and programs, when taken as whole, to conform to the SIP. This necessitates greater coordination and cooperation between transportation and air quality officials during the development of both the transportation plans and programs, and the SIP to insure that sufficient control measures are included in the implementation plans to achieve timely attainment of the standards and required emission reductions.

At the project level, three conditions need to be demonstrated in order to make a conformity determination. One is that the project has to come from a conforming plan and program. The second is that the design concept and scope of the project have not changed significantly since the plan and program were found to conform. And the third condition is that the design concept and scope of the project at the time of the conformity determination for the program was adequate to determine emissions. These provisions ensure that only those projects that come from a conforming plan and program, and whose design concept and scope have not changed significantly from those contained in the plans and programs, can proceed without additional analysis. The design concept and scope refer to the number of types of lanes (i.e., whether they are mixed flow, bus or HOV), degree of access control, etc.

A project whose design concept and scope have changed significantly, or a project not derived from a conforming plan or program, would have to be analyzed in the aggregate with other projects in the conforming plan and program to determine if the project would cause such plans and programs

to exceed their emission reduction projections and schedules. If it does, then State and local transportation officials have the choice of either not advancing the project; modifying the project to offset the emissions; or committing to other changes in the transportation plans and programs, or to measures which are enforceable through the implementation plan, that offset such emissions.

While SIPs are being revised, there are requirements for interim conformity determinations for transportation plans, programs, and projects. Under the interim procedures, transportation plans and programs conform if their emissions are consistent with the most recent estimates of mobile source emissions, if they provide for expeditious implementation of the TCMs in the previously approved or promulgated SIP, and if they contribute to the annual average emission reductions consistent with those specified in the Act for ozone and CO nonattainment areas.

Projects conform during this interim period if they come from a conforming plan and program and, in CO nonattainment areas, analyses show that they eliminate or reduce the number and severity of violations of the CO standard in the area substantially affected by the project. Projects may come from plans and programs that were found to conform in accordance with the interim procedures noted above, or from concurrent programs that were found to conform under procedures in effect before enactment of the CAAAs. In the latter case, the conformity findings are valid for a period of 12 months after enactment of the CAAAs, provided that the program was found to conform within 3 years prior to enactment.

Planning Procedures

The CAAAs provide for review and update, if necessary, of existing air quality planning procedures. It also provides for assigning responsibilities for plan development and implementation. While the 1977 CAAAs made it clear that the MPO should be the organization to develop the transportation

portion of the SIP, the 1990 CAAAs are less clear on this point. For example, the new Act indicates that the State certified organization for preparing the SIP shall include local elected officials, and representatives of the State air quality planning agency, the State transportation planning agency, the MPO, the organization responsible for the air quality maintenance planning process, and any other organization responsible for developing, submitting, or implementing the SIP. The committee report that accompanied the Senate bill, however, indicates that this provision should not require changes in existing responsibilities where relevant State, local and regional agencies have reviewed these issues and reached agreement within the last 2 years.

Emission Reduction Requirements in Moderate and Higher Classification Ozone Nonattainment Areas

Within 3 years of enactment of the CAAAs of 1990, the States with moderate ozone nonattainment areas must submit SIP revisions that demonstrate emission reductions of at least 15 percent in the first 6 years for volatile organic compounds (VOC). These emission reduction estimates must account for any growth in emissions that occur after enactment. Emission reductions from motor vehicle exhaust or evaporative emissions, promulgated by EPA by January 1, 1990, or controls on fuel volatility promulgated by EPA after enactment of the CAAAs of 1990 cannot be credited toward the required 15 percent reductions. Measures required to correct SIPs under EPA guidance, and measures required to correct inspection and maintenance programs also cannot be credited toward the demonstration of the 15 percent reduction.

In addition to meeting the 15 percent emission reduction target noted above; Serious, Severe, and Extreme areas must submit SIP revisions within 4 years of enactment that demonstrate VOC reductions that average 3 percent per year each consecutive 3-year period after the initial 6-year period.

Transportation Control Provisions in Serious and Higher Classification Ozone Nonattainment Areas

Beginning 6 years after enactment of the CAAAs of 1990 and each third year thereafter, States must submit data demonstrating whether aggregate vehicle mileage, aggregate vehicle emissions, and congestion levels are consistent with projected levels included in the SIP. Where the monitored levels exceed projected levels, SIP revisions that include TCMs are due within 18 months that will reduce emissions to levels that are consistent with those contained in the SIP which demonstrated attainment of the air quality standards. The revisions are to be developed in accordance with guidance issued by EPA.

Vehicle Miles Traveled Provisions In Severe and Higher Classification Ozone Nonattainment Areas

Within 2 years of enactment, States with severe ozone nonattainment areas must submit SIP revisions that identify and adopt TCMs to offset any growth in emissions from growth in VMT or growth in vehicle trips. Employers of 100 or more will need to reduce work-related trips and VMT of their employees in accordance with guidance issued by EPA.

Traffic Control Measures During Heavy Traffic Hours In Extreme Ozone Nonattainment Areas

Currently, Los Angeles is the only area that is classified as Extreme. Its SIP revisions may contain provisions to reduce the use of high polluting or heavy-duty vehicles during heavy traffic hours.

Vehicle Miles Traveled Provisions in Carbon Monoxide Nonattainment Areas

Within 2 years of enactment, CO nonattainment areas with design values above 12.7 ppm must revise their SIPs to contain annual forecasts of VMT in the area for each year until attainment. The forecasts must be made in accordance with guidance issued by EPA, in consultation with DOT, within 6

months of enactment. The SIP revisions must include contingency provisions to provide for the implementation of specific measures to be undertaken if VMT levels exceed the amount forecast or if the area fails to attain the CO standards on time. The contingency measures are to take effect without further action by the State or EPA.

Vehicle Miles Traveled Provisions In Serious Carbon Monoxide Nonattainment Areas

Within 2 years of enactment, Serious CO nonattainment areas must revise their SIPs to provide for the identification and adoption of TCMs to offset any growth in emissions from growth in VMT or growth in vehicle trips.

Failure To Meet CO Emission Reduction Milestone

By March 31, 1996, Serious CO nonattainment areas must submit data to EPA demonstrating that they have achieved CO emission reductions equal to the total specified annual emission reductions required by December 31, 1995. If a State fails to make the submission or achieve the total reductions, the State must submit a SIP revision, within 9 months of notification, to implement an economic incentive and transportation control program. The program may include incentives and requirements to reduce vehicle emissions and VMT, and must be sufficient to achieve the specific annual reductions in CO emissions set forth in the implementation plan.

Transportation Planning Guidance

The EPA is required to update the 1978 transportation and air quality planning guidelines within 9 months after enactment and after consultation with DOT and public comment. These guidelines are intended to provide a framework for a continuous transportation and air quality planning process, and provide guidance on the development and implementation of transportation-related and other measures deemed necessary to attain and maintain the NAAQS.

Miscellaneous Guidance on Transportation Control Measures

The EPA, after consultation with DOT and opportunity for public comment, must issue information on the emission reduction potential of TCMs for attaining the NAAQS. A list of 16 TCMs, which is not intended to be all inclusive, is presented. The list includes transit, exclusive bus and HOV roads or lanes, etc. This information is to be published and made available to Federal, State, and local transportation and environmental agencies within 1 year of enactment of the CAAAs.

Transportation System Impacts on Clean Air

The DOT and EPA must submit a report to Congress by January 1, 1993, and every 3 years thereafter. The report must contain the results of reviews of State and local air quality-related transportation programs, including the adequacy of funding for transportation projects identified in the SIP. It must also evaluate the extent to which the DOT's existing air quality-related transportation programs and proposed budget will achieve the goals of the CAAAs. Finally, it must include recommended changes, if any, to existing programs and proposed budgets as well as to any statutory authority relating to air quality-related transportation programs that would improve the achievement of the goals of the CAAAs. Each report after the first one must include the disposition of recommendations from the preceding report.

Summary

In summary, the CAAAs of 1990 place a heavy burden on the transportation community for improving air quality in nonattainment areas. The above noted transportation provisions will change the processes for developing transportation plans, programs, and projects; and will require greater emphasis of demand management strategies, and operational improvements for the existing transportation infrastructure. The transportation community faces many challenges ahead in providing for a safe and efficient transportation system, reducing congestion levels, and controlling mobile source emissions. To meet these challenges, transportation and air quality officials need to establish new partnerships and cooperative approaches for identifying innovative solutions to transportation and air quality problems.

State and local planning, and air quality officials will need to coordinate early in the development of land-use plans and transportation alternatives to ensure that air quality concerns are adequately considered. This early coordination is important because local land-use decisions will often dictate the transportation systems that are needed in major metropolitan areas. It is also especially important that State and local transportation and air quality officials coordinate early and continuously during the transportation system planning and SIP development processes. It is at this stage in the overall transportation development process that air quality considerations can be most effectively evaluated.

STANDING COMMITTEE ON PLANNING

Transportation Provisions of the Clean Air Act Amendments of 1990

GARY HAWTHORN

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As a panelist at the recent Region 9 Intermodal Planning Group conference in Palm Springs, I was reminded that health problems caused by air pollution seldom receive much attention at such meetings. Discussions on transportation-air quality issues tend to plunge right into details. Those details that most directly affect and may interfere with ongoing programs and practices.

Health effects received little if any attention in the recent and many intense debates about the specific statutory language of Clean Air Act transportation provisions; and are unlikely to receive much in the equally intense discussions now beginning on how to interpret and implement the new amendments.

So before jumping into details of new transportation provisions, I will cite some recent evidence that suggests why emission reductions are necessary.

The first-ever study to find serious human lung damage in a severely polluted area was reported on in March. This University of Southern California (USC) autopsy study revealed an unexpectedly high incidence of lung disease. Pathologic tests were conducted on 100 seemingly healthy young adults in Los Angeles who died in auto accidents or homicides. Eighty of the one hundred notable abnormalities in lung tissue, and twenty-seven of these had severe lung damage.

The principal investigator, Dr. Russell P. Sherwin of the USC Medical School, indicated that this pilot research cannot yet answer questions on precisely how much air pollution causes or contributes to observed lung problems. Better answers will come, the doctor says, "If we expand the studies and compare different community environments." As a professor of pathology who has examined hundreds of lungs over the years, Dr. Sherwin emphasized that "We have to be concerned that air pollution is playing a significant role."

Dr. Sherwin summarized the study's findings as follows: "...the damage [we observed] would not [yet] have caused noticeable symptoms, because young lungs have a relatively large reserve..." While everyone loses some lung function and reserve over time, "... In essence, these young people were on their way to running out of lung. The question is, how long do you want your lungs to last? Our concern is that air pollution is greatly amplifying injury to the lung and accelerating the depletion of lung reserve...had these young adults lived another ten to twenty years, a substantial number would have developed clinical disease, with symptoms such as shortness of breath or chest pain."

With that introduction I will now attempt to cover 3 areas: first, some trends—nationwide trends in emissions, vehicle miles-travelled (VMT), and congestion. Second, transportation provisions in the

Clean Air Act Amendments of 1990. And finally, conformity.

Future Emissions, VMT, and Congestion Problems

I want to go quickly through some illustrations that help explain why Congress stuck numerous transportation provisions in the Clean Air Act Amendments of 1990.

Emissions

Figure 1 is one of the better, bottom line illustrations of why the new act contains transportation control measure (TCM), VMT, and conformity provisions. It shows the impact that alternative VMT growth rates could have on nationwide auto hydrocarbon emissions out to 2010. Emissions that have

declined since 1970 start upward again near the end of this decade.

The primary questions are:

- At what rate will VMT grow?
- How bad will congestion get?
- How will VMT and congestion increases affect emissions?

VMT Growth

To spotlight my remarks and sharpen your interest about VMT growth, I need only say to this audience that the new amendments require EPA to issue VMT forecast guidance by May 15, 1991. More on this in a moment.

Figure 1. Trends in Light Duty Vehicle Emissions

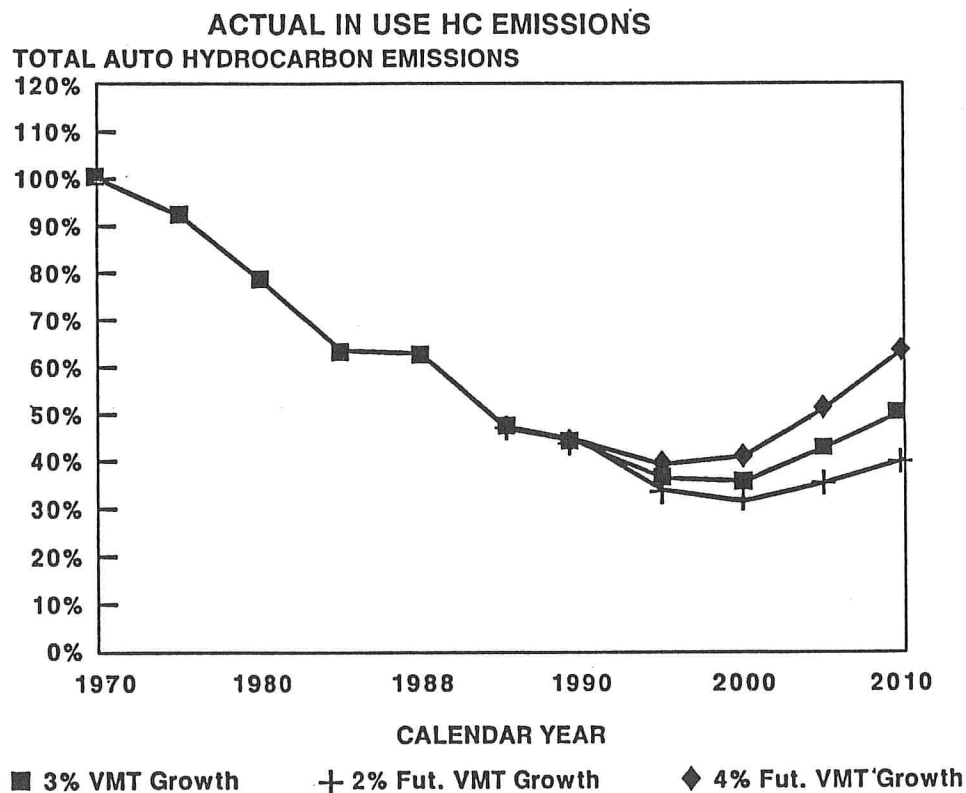


Figure 2. Population & Vehicles & VMT

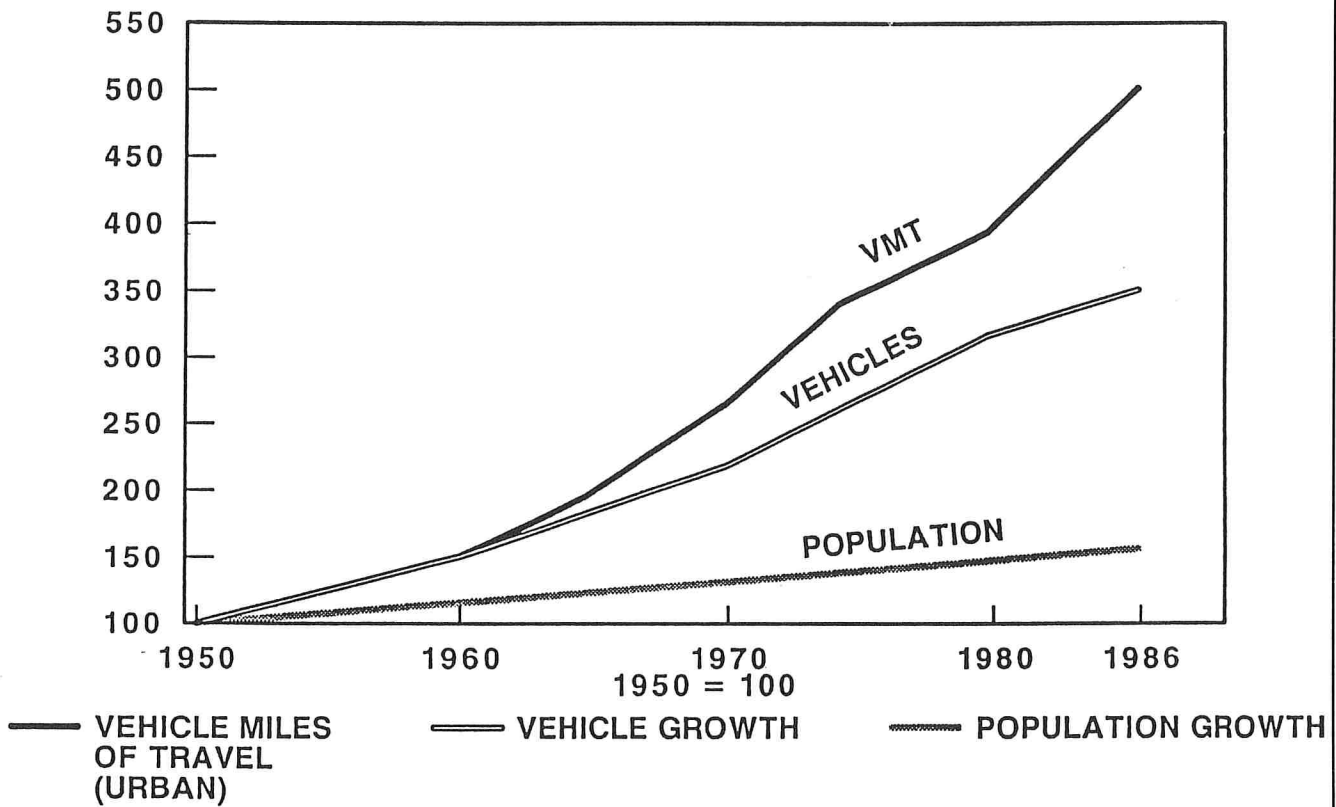


Figure 2 shows the relative growth rates of population, vehicles, and VMT nationwide. Since 1960 vehicle and VMT growth have outstripped population growth by *four to five times*.

Figure 3 shows actual measured VMT for 8 cities for 5 years beginning in 1982. Note that in 5 of the 8, average annual VMT growth for that 5-year period exceeded 6 percent. That concludes looking back.

Figure 4 looks to the future and presents a range of annual VMT growth rate projections for urban areas nationwide. I have read or heard these signifi-

cantly different figures over the past year from various sources in the transportation community. The 6 percent figure comes from the highway users federation, covers from now to 2000, applies to "many urban areas" and would signify—when compounded—a doubling of VMT between now and 2000.

Wisdom cautions that past is not always prologue. That past trends of *actual VMT* should not simply be extended into the future. But on the flip side, wisdom should also caution that past, consistently low *VMT predictions* should not simply be carried into the future either.

Figure 3. Daily VMT Increases: 1982-87

FREEWAYS AND PRINCIPAL ARTERIALS

| <u>URBAN AREA</u> | <u>AVERAGE ANNUAL INCREASE (%)</u> |
|-------------------|--|
| BUFFALO | 2.7% |
| MIAMI | 2.9 |
| HOUSTON | 3.6 |
| PORTLAND | 6.3 |
| SACRAMENTO | 7.6 |
| WASHINGTON,D.C. | 8.8 |
| SAN DIEGO | 9.6 |
| ATLANTA | 11.0 |

SOURCE: TTI REPORT 431-IF

Figure 4. Vehicle Miles-Traveled (VMT)

PROJECTED INCREASES - ANNUAL AVERAGES

1.9%
2.27%
4.0%
6%
?



DOT's Biennial Report to Congress contains a 20-year nationwide projection of expected annual VMT growth rates. Over the last 8 years, the actual average annual VMT growth rate has been 50 percent higher than projected—actually 3.6 percent rather than the projected 2.4 percent. And in many urban areas the rate has been considerably higher as previous slides have shown.

The VMT growth projections used in upcoming State Implementation Plan (SIP) revisions are obviously critical inputs. These are numbers that EPA will critically assess. With unlimited time and money, VMT projections should ideally be treated as a range of numbers in sensitivity analyses.

Congestion

Regarding congestion, the inescapable conclusion is that big increases in congestion and emissions will result from big VMT increases and small increases in system capacity—whether from new or smart highways. Smart cars, or traditional traffic flow improvements. Figure 5: the recent *Congestion Toolbox* document, published by the Institute of Transportation Engineers, provides some staggering/sobering nationwide figures on just how much congestion could increase by 2005 by road and area type. Let these numbers sink in...imagine how these 300-400 percent increases would affect your commute trip and translate into increased aggravation, delays, and emissions.

Figure 5. Increases in Nationwide Congestion 1985–2005

• URBAN FREEWAY DELAYS:

360% CENTRAL AREAS

433% OUTLYING AREAS

300% AREAS OVER ONE MILLION POPULATION

1000% AREAS UNDER ONE MILLION POPULATION

• NON-FREEWAY DELAYS: 200%

SOURCE: ITE Toolbox for Alleviating Traffic Congestion

The organization "TRIP" (The Road Information Program), recently estimated congestion's impact on emissions in 4 California cities. As reported, congestion on Los Angeles freeways increased hydrocarbon emissions by 46 percent in 1988. Despite cleaner vehicles, this figure could increase to 72 percent by 2010 due to a worsening of congestion.

This 72 percent translates to 55 tons per day. According to the 1989 Air Quality Management Plan (AQMP), the maximum hydrocarbon emissions in 2010 that could demonstrate attainment would be 200 tons per day. So congestion alone could cause over 25 percent total allowable hydrocarbon emissions in 2010.

Summary

The bottom line concern is that the growth in vehicular usage will overwhelm emission reductions achieved by more tightly controlled and cleaner fueled cars. *Most significantly*, VMT increases on congested roads will cause a disproportionally larger increase in emissions.

Transportation Provisions— General

The original Clean Air Act of 1970 was only 65 pages long. The 1990 amendments go on for nearly 800 pages. I will sidestep many details and offer bottom line observations on just 14 provisions. These cover 40 of the Act's 800 pages—or about 5 percent of the Act.

Highway Sanctions

The 1990 Act increases the possibility and geographic coverage of highway sanctions in the future. Previously, highway sanctions were only applied for failing to submit, or make reasonable efforts to submit, a SIP (i.e., for planning failures). But now sanctions can be triggered when EPA disapproves a SIP or for a failure to: (1) make *any* submission required by the Act or (2) *implement any* SIP provision.

Highway sanctions can also now be applied statewide under certain circumstances. And EPA has a greater say in allowing exemptions—i.e., for transportation projects that may improve air quality.

However, because the statute expands the list of exempted projects, sanctions may become less of a blunt instrument. Seven types of programs/projects are now explicitly exempted—ones that emphasize moving people vs. vehicles. The list loosely covers HOV incentives, SOV disincentives, and congestion relief. While these projects may have eventually been exempted under past procedures, the new statute may somewhat reduce the administrative burden of the exemption process.

Perhaps some historical facts on EPA's past use of sanctions—their duration, impact, etc., will also be somewhat reassuring. Since 1980, EPA imposed highway sanctions in 7 states. In 5, the sanctions applied to just one urban area. In 3 of the 7, sanctions were in effect for less than 2 months and for less than 2 years in 2 of the remaining 4. In the 1980's, media headlines notwithstanding, sanctions appear to have delayed few highway projects and a small percentage of Federal highway dollars.

Planning Procedures

The next provision—planning procedures—require state and local elected officials to: (1) review and, if necessary, update SIP planning, implementation, enforcement, and funding responsibilities and (2) certify and organization to prepare the SIP. This organization shall include local elected officials and representatives of the State Air Agency, MPO, and State DOT.

This up-front determination of SIP responsibilities—establishing the institutional foundation—is especially critical in the transportation area. "Who is supposed to do what when" should be determined and agreed on at the beginning. The process should lay out procedures and a sequence of decisions required to develop "committed to" measures needed in an approvable SIP.

The 1989 Air Quality Management Plan for the Los Angeles area demonstrates the growing institutional complexity. The implementing authority for its 160 measures is split and shared among many agencies and all governmental levels. The air district has authority for 75 measures, the State air agency for 15, local governments for 12, transportation agencies for 10, and other State and Federal agencies for 9. No authority is specified for 13 measures and more than one authority is specified for 26 measures.

VMT Forecast Guidance

As promised, I am returning to VMT forecast guidance. Congress requires EPA, in consultation with DOT, to issue this guidance in 6 months.

Why did Congress put EPA in the VMT forecast business? I am uncertain about the origins of this requirement. But I suspect that Congress is concerned that VMT projections, as shown in my opening material, have historically and consistently been significantly underestimated. And second, that annual VMT projections are all over the lot.

If VMT growth is underestimated, EPA optimistically, and incorrectly, projects attainment of the standards. Such faulty projections, which have occurred in the past, please neither EPA nor Congress. But I suspect that others in the transportation profession would also like to see accurate VMT projections.

Perhaps this Clean Air Requirement creates an opportunity to achieve some improvements in the short, or more likely, long term. Do low VMT projections suggest that existing models are omitting key travel-determining factors? That new data are needed on travel behavior, i.e., better information on how we are really using our vehicles? I would welcome comments and suggestions on this issue.

Transportation Air Quality Planning Guidelines

In turning to the fourth item, the act requires EPA, in consultation with DOT and state and local

officials, to update within nine months the 1978 EPA-DOT *Transportation-Air Quality Planning Guidelines*. This is planning process guidance aimed at coordinating SIP transportation activities with DOT's 3C planning and programming process.

TCM Information Documents

The 1990 Amendments also require EPA, in consultation with DOT, to issue within 12 months TCM information documents on 16 measures. The documents will cover the emission reduction potential of TCMs, as well as other costs, benefits, and implementation guidance. Drafts of the documents should be ready in the spring.

Report to Congress

DOT and EPA must submit a report to Congress every three years beginning 1993. The report must assess how well U.S. DOT, state, and local air quality-related transportation programs are achieving the goals of, and compliance with, the Clean Air Act.

The report must focus on: (1) adequacy of funding for SIPs TCMs, (2) Federal efforts to promote SIP TCMs, (3) an evaluation of DOT's air quality-related program and budget, (4) recommendations for DOT program, budget, and statutes, and (5) implementation of previous recommendations.

Transportation Provisions— Ozone Areas

Clean Air Act transportation requirements vary by pollutant and increase in number and stringency with the severity of pollution.

Moderate

Moderate ozone areas must submit SIP revisions in 3 years that reduce Volatile Organic Compounds (VOC) by 15 percent over the 6 years following enactment. That is, immediate emission reductions in years 1991-93 should be demonstrated in the SIP submitted in 1993. This is a "net" reduction because

in addition to the 15 percent, emissions due to growth must also be offset. *And* because reductions from several Federal programs (e.g., Vehicle Exhaust, "EVAP," and fuel volatility) cannot be credited toward the required 15 percent reduction.

Serious

Serious areas must, of course, carry out moderate area requirements. But they must also carry out "VMT verification and mitigation". This requirement kicks in 6 years after enactment.

Simply stated, this 2-step provision first requires periodic checks of VMT and congestion: a periodic demonstration every 3 years that current VMT, congestion, and emissions are consistent with those being assumed for mobile sources in the SIP.

If the demonstration cannot be made, the SIP would then have to be revised within 18 months to "reduce emissions to levels" necessary to demonstrate attainment. The SIP revisions shall "include TCMs from, but not limited to, section 108(f)." So the act mandates TCMs—in effect saying that mobile source emission problems should be corrected with transportation controls. The key follow-up question is whether such emission problems must be fixed *exclusively* with TCMs. The definitive answer must await future EPA policies and guidance.

Severe Areas

The mandatory TCM requirement applies sooner and is more stringent for severe areas, these areas must submit—within 2 years of enactment, as opposed to 6 years for serious areas—SIP revisions containing TCMs. The TCMs must: (1) offset growth in emissions due to growth in VMT and vehicle trips and (2) help achieve the required 2-1/2 percent annual emission reduction requirement.

Within 2 years of enactment severe areas must also revise SIPs to include an employer trip reduction program in accordance with EPA guidance. The statute specifies that employers with 100 employees or more must increase the Average Vehicle Occupancy (AVO) of employee work trips by 25

percent above the area average. Employer plans, due 4 years after enactment, must demonstrate compliance 6 years after enactment.

Extreme Areas

The single extreme area—Los Angeles—must implement the above transportation requirements for moderate, serious, and severe areas. In addition, its SIP revision *may* contain provisions to reduce the use of high polluting or heavy duty vehicles, "notwithstanding any other provision of law." First, I want to underscore that such restrictions *may* be implemented—they are *not* required by the act. Semantics aside, the "notwithstanding other provisions of law" part of this provision *may* help reduce legal and other obstacles to truck restrictions but will probably only do so after legal challenge.

Transportation Provisions— Carbon Monoxide Areas

Moderate Areas

Similar to serious ozone areas, the two requirements for moderate CO areas can also be described as "VMT verification and mitigation": within 2 years of enactment, moderate CO areas—currently 38 areas—must revise SIPs to contain annual VMT forecasts until attainment. The forecasts must be based on EPA guidance. The SIP revisions must also include contingency measures to be automatically implemented if VMT levels exceed projections or if attainment by the deadline is missed.

Serious Areas

The TCM requirement is similar to that required for severe ozone areas, i.e., within two years these areas must revise SIPs to implement TCMs to offset growth in emissions due to growth in VMT and vehicle trips. The rejection of TCMs from the section 108(f) list requires an explanation and a demonstration that comparable emission reductions will be achieved by alternative measures.

Finally, if a serious CO area fails to achieve the emission reductions required by 1995, the state must, within nine months, implement "an economic incentive and TCM program" that reduces VMT and emissions to achieve necessary annual increments leading to the attainment date.

Conformity

I have often called "conformity" one of the great eye-glazing topics. After hearing about conformity a while back, a former EPA assistant administrator compared my briefing and the subject of conformity to Chinese food. His words were: "good and enjoyable to digest. But gone in about 30 minutes."

Background

The conformity provision in the 1977 Clean Air Act amendments consisted of thirteen lines. The 1990 amendments did not change this original language, which is now the opening paragraph to the new conformity section. To paraphrase:

All Federally approved or financially assisted actions must "conform" to "SIPs". MPOs cannot approve any project, program, or plan that does not "conform" to the SIP. Assurance of "conformity" to the SIP is an affirmative responsibility of each Federal agency head.

I should add that the 1977 act did not define "conformity".

Following this opening thirteen-line paragraph, Congress added 145 new lines over seven pages to cover the new expanded conformity requirement. As we descend into the details, please keep reminding yourself that, on the surface, the concept of conformity is simple and logical: transportation and air quality plans should conform or be consistent with each other.

Key Elements of the Conformity Provision

Agency Responsibilities

There are six key element to the new conformity provision. First, the Act maintains the existing, basic agency responsibilities: MPOs and DOT demonstrate and assure conformity—not EPA.

Conformity Definition

Second, Congress defines conformity in the statute. As I said before, the 1977 act did not define conformity. This omission resulted in disagreements between DOT and EPA. The 1990 amendments define conformity generally, by stating that conformity to the SIP means conformity to the SIP's purpose of reducing the severity and number of violations and expeditiously achieving standards.

And then the definition gets more specific, by stating that transportation plans and programs conform if: (1) emissions from such plans and programs are consistent with SIP emissions projection and reduction schedules (i.e., with projections and reductions assigned to those transportation plans and programs in the SIP) and (2) the plans and programs provide for timely implementation of SIP TCMs consistent with SIP schedules.

Conformity Criteria for Projects

Third, the statute provides criteria for demonstrating project conformity, which was another area of past disagreement between DOT and EPA. Simply put, projects conform if they meet three criteria:

- The project comes from a conforming plan and program.
- The project's design and scope, i.e., emissions, do not change significantly, i.e., increase, from the time of the conformity finding of the project's plan and program.

- The project's design and scope was adequate to determine emissions at the time of the conformity determination of the project's program.

If projects meet these criteria, no further individual analysis would be necessary to demonstrate conformity for regionwide pollutants.

However, projects that cannot meet these three criteria would be subject to further analysis and could only be found in conformance if projected emissions from the project, together with those from the conforming plan and program, do not exceed the emission projection and reduction schedules assigned to such plans and programs in the SIP.

Interim Conformity Criteria

There are remaining three parts of the conformity provision. The first deals with interim conformity determinations. Because conformity demonstrations require that SIP TCMs be implemented and emission targets met, questions arise about how to make such demonstrations from now until SIPs are revised, i.e., prior to adoption of TCMs and the setting of emission targets within revised SIPs? How can the TIP be compared to a SIP undergoing revision?

To help answer these questions, the 1990 Act provides interim conformity criteria that apply until approval of SIP revisions that are due within 24 months. These SIP revisions must include conformity procedures and criteria that respond to the Act's new conformity requirement. And, presumably, to the conformity procedures and criteria that EPA must promulgate within one year.

In order to be found in conformance during this interim period, transportation plans and programs must meet three criteria, two of which are: first, the plan and program must provide for expeditious implementation of TCMs in applicable SIPs. This means that stalled TCMs "laying around" in existing SIPs must be implemented.

Second, plans and programs must "contribute"

to required annual emissions reductions. For ozone this means "contributing" to a 15 percent reduction in hydrocarbon emissions over the first six years after enactment. Straight division shows that plans and programs would have to "contribute" to 2-1/2 percent annual emission reductions.

For carbon monoxide (CO), plans and programs would also have to "contribute" to annual emission reductions, subsequently determined on the basis of each area's design value, i.e., CO levels, and attainment deadline.

During this interim period, conforming transportation projects would have to meet two criteria. First, the project must come from a conforming plan and program. That is a plan and program that meets the criteria just mentioned (e.g., contributing to a 2-1/2 percent annual emission reduction) *or*, for 12 months after enactment, a plan and program found in conformance within three years prior to enactment. Second, in CO containment areas, the project must eliminate or reduce the severity and number of violations in the project's vicinity.

EPA and DOT recognize the need to issue interpretive guidance in the very near future on these interim criteria and procedures. The guidance should address: What "contributing" to annual emission reductions means, analytical approaches for making conformity determinations in this interim period, and other questions that both agencies are getting from the field.

EPA Procedures and Criteria

Let me leave the interim period and return to the situation after SIPs are revised. EPA, with DOT's concurrence, must promulgate within one year criteria and procedures for demonstrating and assuring conformity. These more detailed procedures and criteria will have to translate the statute's broad language into an operational form that covers, as but one example, analytical techniques for demonstrating conformity.

According to the statute the procedures and criteria must also, at a minimum, address:

- Consultation among MPOs, state transportation and air quality agencies, and DOT prior to final conformity determinations
- The appropriate frequency—never less than every 3 years—of conformity determinations for plans and programs
- How conformity determinations relate to air quality maintenance plans

Conformity in SIP Revisions

States, within 24 months of enactment, must include conformity procedures and criteria in a SIP revision. By requiring this revision, Congress insures that EPA's regulatory and sanction leverage is available to correct serious conformity deficiencies. And that state air agencies will be more involved in the conformity process.

This new conformity definition and approach places a greater burden on the transportation program by shifting the conformity process from a comparison of plans during system planning to an analytical process for plans, programs, and projects.

Conclusions

Money, Money, Money

So who will pay for all the transportation activities required by the 1990 Clean Air Act Amendments?

As a reminder, the two infusions of Section 175 funds from the 1977 Act totalled \$50 Million nationwide, with about \$3.2 Million going to the Los Angeles area and \$1.45 Million to the Bay area, as examples of past area grants.

This kind of money buys a lot of analyses, interagency interaction, and consultation among officials, agencies, and organizations. If no new funds are provided, common sense says that the scale and quality of activities will suffer.

Buried deep in Title VIII of the new Act, Section 822 authorizes \$50 million to be appropriated. Given prevailing deficit/budget problems, can anyone expect these funds to be appropriated any time in the foreseeable future? Can anyone imagine OMB not opposing this \$50 million appropriation? Perhaps an organization, such as the national association of regional councils (NARC)—the MPO lobby—has a strategy to get these needed funds appropriated.

Emission/Congestion Link—Common Problems & Solutions

Congestion and emission problems are closely related and will worsen in tandem. Clean Air TCM activities can yield congestion relief benefits. Clean Air Requirements can create opportunities to enhance ongoing congestion abatement efforts because the dual objectives of congestion *and* emission reductions can be achieved.

Congestion management plans, already required in California, will hopefully be emphasized in new Federal transportation legislation, planning REGs, and budgets. A while back, the highway users federation recommended 10-year congestion management plans for urban areas. Good idea. But let's add emission reductions to the undertaking and do a single plan and process. At NARC's annual meeting in June, Kevin Heanue—with words and a handout—said that the process of developing CMPs would be coordinated with the SIP process. This is an important first step in the right direction.

Return to Human Lungs

Another USC researcher from that previously mentioned autopsy study said: "Youngsters growing up in LA suffer a 10 percent to 15 percent loss of lung function compared to children who live where the air is less polluted." Certainly a sobering observation, especially for parents in Southern California. While LA clearly has the nation's most serious pollution problems, we should still consider how lesser pollution levels may be affecting children's lungs in other nonattainment areas.

And also consider Mexico City—what LA might have been without the world's most strict pollution controls. Los Angeles's peak ozone level—the design value—is .33 ppm or almost three times the national standard. In LA the standard is exceeded about 135 days of the year—about 37 percent of the time.

In contrast, Mexico City's peak ozone concentration is .44 ppm or about four times that country's standard. And in Mexico City the standard is exceeded a whopping 88 percent of the time, or just about whenever the sun shines. For all inhabitants, there is no relief—no escaping the unhealthy air.

STANDING COMMITTEE ON PUBLIC TRANSPORTATION

Building Coalitions and Financing Transit Programs

JAMES P. TOOHEY
*Assistant Secretary,
Planning, Research and Public Transportation
Washington Department of Transportation*

I will address Washington State Department of Transportation's (WSDOT) responsibilities and involvement with public transportation. These include:

- the strategic management and planning processes
- growth management initiatives
- transportation funding
- transit efficiency, effectiveness and benefits studies, and
- innovative alternatives and future efforts.

Nine years ago it became obvious that we, as the Department of Highways, could no longer build our way out of congestion and traffic problems. By changing to the Washington State Department of Transportation, which included a Public Transportation Office, our organization had more opportunities and alternatives to address the ever-growing problems of congestion in our communities.

Secretary Duane Berentson has established a strategic management philosophy which states:

"Our objectives must focus on activities...to maintain mobility and ensure cost effective alternatives for transportation of Washington's people and products. We can no longer focus on just moving vehicles."

Within my division, which is Planning, Research and Public Transportation, our Mission Statement is:

"To ensure WSDOT and other transportation decision-makers have the innovative policies, systems, plans, and research needed to lead the state into the future."

"To ensure public transportation systems and services meet the needs of the citizens."

"To provide technical services and data to support transportation systems development"

Through our strategic planning process, we have taken steps to ensure a multimodal transportation system which meets the social, economic, and environmental needs of the state by:

- aggressively promoting, planning, and implementing HOV lanes

- supporting transportation system management (TSM) techniques to mitigate congestion (and save energy)
- enhancing transportation demand management (TDM). This includes programs aimed at changing travel habits through alternative travel modes and employer/employee incentive programs.

These steps also include the ongoing mobility needs evaluation of our rural and more isolated areas as well as the needs of our elderly and handicapped.

Transportation problems in Washington State have increased dramatically over the past several years due in large part to rapid growth of the Central Puget Sound area. Prior to 1990, cities and counties had an option of developing comprehensive plans which could contain both a land use and a transportation element. Little specificity was provided to those plans. Now with the Transportation Revenue Package and Growth Management legislation, transportation issues must be addressed on a regional basis.

In Washington State, growth management is now defined as "Consistent planning tied to consistent implementation". We are studying growth management and transportation issues as they relate to:

- population growth
- traffic congestion
- inadequate sewer, water and other key facilities
- changes in neighborhoods
- environmental pollution, and
- unbalanced growth.

Since the early 1970s, Washington State has promoted a balanced approach to funding public transportation programs—local, state, and federal.

Washington state has a unique way of locally funding public transportation through a legislative sanctioned, voter approved process. The Public Transportation Benefit Area legislation was enacted in 1975, and we currently have over fifteen established PTBAs in our state today. Through the PTBA process, boundaries are adopted, a transportation plan is presented and reviewed by WSDOT, and a local sales tax initiative is presented to the voters within the PTBA boundary. With collection of a local sales tax, the PTBA is able to match, dollar for dollar, motor vehicle excise taxes collected by the state to fund their transportation programs.

This type of funding encourages communities to develop transit systems in their geographical areas which meet their own particular needs. A current example of this process is the newly established Chelan/Douglas PTBA which is located in a semi-rural conservative community in the state. Their local transit tax initiative was recently approved at a time when most all other tax proposals were rejected.

With our innovative local and state funding of public transportation, we have maintained our responsibilities in public transportation financing.

The decreases in federal funding are creating a lag in the transportation partnership commitment. The federal government worked with us to make the initial investment. My position is that we want to maintain our working partnership and encourage more federal government participation in these projects. We need stability and assurance that long-term transportation planning and financing will continue as a national priority.

One example that has had a major impact on the effectiveness of public transit in the Seattle area is our HOV program. Of the more than 150 miles planned in the 1980s, only 40 miles have been completed. Our federal partner has pulled back on its commitment. However, I am encouraged by Secretary Skinner's proposal in the reauthorization program for a special congestion fund which will look at HOV, park-and-ride lots, and other transit-oriented facilities.

I will continue to do my part to influence the reauthorization effort and certainly appreciate what AASHTO is doing along those lines as well.

In spite of the federal funding situation, Washington State is developing a good sound public transportation system including:

- Programs which positively affect the overall congestion management needs of our urban areas,
- A sensitivity toward specialized and rural issues, and
- an emphasis on mobility.

However, we believe that it is now appropriate to evaluate these services, programs and benefits, and plan for future public transportation needs; therefore,

- Through an independent, comprehensive study, this state is taking a look at our public transportation programs and services.

This study shall include an analysis and evaluation of:

- The roles and benefits of transit and paratransit in various areas of the state,
- The effectiveness and efficiency of public transportation efforts including utilization, cost of service, growth management strategies, environmental factors and financial support,
- The unmet transportation needs of disabled, elderly or other transportation-disadvantaged persons, and
- The state's role in public transportation including provision and coordination of transportation services.

This Legislative Public Transportation Study is appropriate at this time as we have never had a strong state goal for public transportation.

We, at WSDOT, are convinced that public transportation can play a key role in managing our mobility issues, but we have much work ahead to get legislative support to further the cause of public transportation.

Transit must be at the table when issues are discussed and decisions are made regarding land use, clean air, the economy, energy conservation, and improved quality of life. UMTA Administrator Brian Clymer, at a recent conference expressed concern that transit's message has not been heard much within the halls of U.S. DOT. However, with the leadership of Secretary Skinner, Federal Highway Administrator Tom Larson, and Mr. Clymer are talking about projects that will benefit both agencies. We need this cooperation at the state and local level as well. Our transit systems must look beyond the traditional method of service delivery—that of the fixed-route approach. The systems must become full-service transportation agencies which offer a variety of alternatives that people will use.

Because of the conditions in the Middle East, we are waking up to the fact that coalitions in the public transportation community are needed at the local, regional, state and national levels.

How is Washington State reacting to the recent events in the Middle East?

- Assisting Governor Gardner through the State Energy Office, the transit community is contributing to planning for emergency contingency measures.
- This state's major transit and ridesharing organizations are armed with programs already in place. Through WSDOT, the State Transit Association and the Washington State Ridesharing Organization have developed a network through which carpool, vanpool, and transit information and services can flow freely to citizens of the state. Public service announcements are being prepared to direct people to these services.

Here are four recent examples of energy initiatives within the state:

1. Pierce Transit, located in Tacoma, Washington, will place 19 buses on the road this year which will operate with compressed natural gas. In late 1991, 15 more CNG coaches will be delivered.
2. Downtown Seattle Transit Tunnel. This 1.3 mile tunnel is designed to relieve traffic and pedestrian bottlenecks above ground by removing buses and bus riders from streets and sidewalks. Buses can go through downtown three times faster than buses on surface streets. This energy-conscious public works project, with its direct linkage to Interstates 5 and 90, represents the positive outcome from state and local jurisdiction cooperation, coordination, planning, and project management.
3. In partnership with the state government, Intercity Transit has begun a shuttle service to the state capital campus. The shuttle provides free rides at ten-minute frequencies. It has reduced the need to use private or state cars to conduct business around the campus—reducing energy use and increasing employee productivity.
4. Our Public Transportation Office is purchasing vans to be available on an immediate basis to newly formed vanpool rider groups.

Public transit, through these and many other examples, can make a difference. The challenge will continue for the transit community to get the message out through the coalition process that it is a viable alternative.

In summary, there are several efforts taking place which I believe will position public transportation in the future:

1. Incorporation of public transportation objectives into the overall strategic planning of the Department of Transportation.
2. Planning and growth management initiatives which address the regional nature of transportation problems facing the state, and comprehensive plans at the local government level which require transportation planning as a mandatory element.
3. Sustaining or enhancing transportation funding from all three partners—local, state, and federal.
4. Special studies which continue to evaluate transit efficiencies, effectiveness, and benefits, as well as the needs of elderly and disabled individuals.
5. Supporting full service transportation agencies which go beyond the traditional service and offer a variety of alternatives that people will use.

SPECIAL COMMITTEE ON INTERMODAL ISSUES

Forging Systematic, Synergistic & Seamless Transportation

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This paper is part of a series of selected intermodal issues prepared by members of the Technical Advisory Committee of the AASHTO's Special Committee on Intermodal Issues. The ideas and recommendations presented herein are mine and this is not an official statement of Port Authority policy. I am appreciative to the assistance I received from several co-workers including Donald Lotz and Robert Beard, Port Intermodal Development, Joseph Birgeles, External Affairs and Gerhardt Muller, Office of Business Development.

Intermodal services figure prominently in Bi-State operations of Port Authority's airports, its interstate passenger network (our Path railroad as well as tunnels and bridges) and port facilities. The Port Department provides marine related intermodal services at facilities located in Brooklyn, Manhattan and Staten Island, New York and at Port Newark/Elizabeth in New Jersey. This port complex is one of the largest in the world. Currently, New York/New Jersey is among the top three port gateways in the United States—seventh in the world in terms of container volumes.

Modern intermodal technology is helping to redefine the way goods move between nations and within the United States. The efficiency of intermodal systems and the volume of goods they handle have grown dramatically over the past decade. The intermodal transportation option has joined trucking, rail, marine and air as a distinct, stand-alone service system. It is important for transportation officials to understand the unique aspects of intermodal technologies and how *they*, as custodians of essential public infrastructure, can contribute to intermodal as well as single modal systems development.

Overview

The purpose of this paper is to provide state transportation officials with an overview of key intermodal concepts and how intermodal technological improvements can impact future goods movement. It defines intermodalism generally and follows with a description of major technologies—focusing on marine-based container systems which are now being extended to domestic use. Finally, it considers the role that the public sector, especially the states, should play in intermodal development and makes recommendations for public sector

activities that foster technological and managerial improvements.

Intermodalism is a transportation management concept that aims to reduce the time and/or cost involved in moving goods or people through the use of one or more modes arranged in efficient sequences from origin to destination. Intermodalism is a battle against inertia—the full stops and restarts at transfers that slow deliveries and raise costs. For intermodal transportation to be truly effective, it must be **systematic, synergetic and seamless**. Following are key intermodal technologies and their operational functions:

- **surface transportation technology** includes containerships, locomotives, trucks, rail cars/chassis, piggyback trailers and containers;
- **transfer technology** embraces container handling equipment such as cranes and yard handlers and other devices used to organize efficiently container ports, terminals and distribution facilities;
- **information technology** encompasses management information systems, automatic equipment identification (AEI) and electronic data interchange (EDI) systems.

These technologies are at different stages of development. Today approximately 50 percent of intermodal technological advances involve operations hardware and port/terminal facility improvements; the other half come from information technology breakthroughs. Some experts predict that upwards to 90 percent of future improvements will be information-based.

Key Technologies

Surface Transportation Technology

Container Ships: Over the past three and one-half decades, container ships have established themselves as the most efficient means to move general

oceanborne cargo. Large container ships (3000+ TEUs) are rapidly becoming the industry norm. Although they constitute only about one-eighth of today's fleet, they account for the movement of about half of the world's oceanborne container cargo. Virtually all of the container ships now under construction are of large design—assuring that these vessels will be a significant force in the future.

Locomotives and Trucks: Over the past 20 years, equipment manufacturers have responded to the need for more fuel efficient and cleaner-burning truck and locomotive engines. Improvements in equipment efficiencies have come from increasingly sophisticated electronic systems that monitor and regulate engine performance and set the stage for "smart" vehicle and "smart" rights-of-way innovations.

Containers: The box or container is perhaps the most critical component of intermodal systems. Although containers come in several lengths, standard marine containers have generally come to mean 20 foot and 40 foot and 8 foot by 8 foot boxes. These sizes dominate among the 4.2 million containers estimated to be in current global supply.

Intermodal operators in the United States, Western Europe and Asia are looking to extend marine-based intermodal systems to domestic use. This extension creates pressures to develop special container equipment which is better designed to meet local distribution needs. It will be critical for the industry to maintain a sufficient degree of equipment standardization to allow international and domestic intermodal systems to develop in a complementary fashion. Billions of dollars in potential revenues ride on how well intermodal supplies can integrate domestic and international systems to serve diverse shipper needs.

Double-Stacks: The most dramatic changes likely to take place will be in the extension of intermodal container equipment to widespread domestic use. Just as jumbo container ships revolutionized ocean carriage, the double-stack rail car is changing the rules of the game in landside intermodal service. It is the leading technology in the extension of containerization into the domestic market.

Double-stack cars use a depressed well or platform to stack containers two-high within most railroad clearance limits. These wells or platforms are articulated in sets of five, adjacent wells being supported by one shared rail truck assembly. Double-stack cars are lighter, shorter, more aerodynamic and give a better ride than other cars. Double-stacks provide the best net-to-tare ratio and carry the greatest number of revenue loads for a given train length. Therefore, they offer cost-effective service on long distance, high volume routes.

Since 1983, double-stack capacity has grown from 400 spaces to an estimated 30,000 slots. Now over 100 double-stack trains move each week between the West Coast and other major metropolitan areas. This system, which now handles 25 percent of all current intermodal volumes, is becoming a substantial force in domestic transportation. Already 9 percent of intermodal container service is dedicated to domestic use.

Spine Cars: Many of the advantages of double-stack service are being extended to lighter density corridors and routes with remaining clearance restrictions by the use of Spine Cars. Spine Cars are essentially "single-stacks"; light-weight articulated cars that carry one container on each of the five units. Over the next five years, they will replace most of today's standard trailer flat cars.

The fact that intermodal systems cannot generally offer cost effective service in short haul markets—creates a major barrier to robust double-stack and spine car systems growth. Shorter distance rail line hauls and longer truck drays sharply limit the competitiveness of rail intermodal systems, especially at distances of 500 miles or less. Since 80 percent of all domestic pickups and deliveries involve trips under 500 miles, it is critical for future intermodal growth to be able to attract traffic within intermediate and short haul routes.

Carless technology portrays intermodal trailers (as opposed to boxes) that can travel either on rail or highway. Carless trailers use smaller terminals and are able to operate in diffuse markets outside of traditional intermodal lanes. Although these sys-

tems now account for about 5 percent of the total intermodal market, they represent a promising low cost means to extend services to shorter distance markets where most of the freight is found. This technology can serve both small and scattered rural shippers and be used to reduce metropolitan highway congestion. A primary producer of this equipment is Roadrailer, Inc. Their equipment is configured like standard piggyback trailers but can add or subtract rail bogeys as needed for easy trailer transfer.

Conventional Cars The future trend is toward a reduction of the railroad industry's large fleet of conventional trailer on flatcar (TOFC or Piggyback) equipment. However, these cars which comprise 55 percent of the current fleet, will be part of the intermodal picture well into the future. They are familiar, easy to operate, can carry higher payloads than most other intermodal equipment and in the absence of major Roadrailer breakthroughs, are economical in light density, short haul markets.

Transfer Technology

Congestion on landside port access routes reduce both the quality of service and the cost competitiveness of services throughout the hinterland market. The movement of containers from shipside by truck to off-dock railroad terminals substantially adds unwanted time and costs to intermodal movements. Increased use of rail-based intermodal services from rail transfer yards within or immediately adjacent to port terminal facilities can produce more efficient operations. However, many ports are not configured to allow easy addition of "on dock" rail. Even if feasible, on-dock services can create a moving wall of containers that reduce overall terminal access. In many instances, rail transfer situated in proximity to the dock—either on or off terminal properties—will prove to be the most effective approach.

Port productivity can be gained from the use of high-speed cranes and other container repositioning technology. This equipment is crucial for making marine transfers swift and continuous. However, it may take 30 years for ports to recover investments

in heavy duty, high speed cranes. This long pay-back period creates a high risk for technological obsolescence to ports seeking these improvements.

Information Technology

Progress made during the eighties has laid the foundation for paperless information and automated cargo processing systems that will become common during the next decade. Grocery chains, automotive giants and textile conglomerates as well as railroads, ocean carriers, truckers, brokers and ports are heavily investing in these technologies. Paperless information systems will be increasingly used to diagnose problems in intermodal transport operations and make whatever corrections are necessary such as: reassignment of vehicles, containers, warehouse space; rerouting or rescheduling of cargo flow; consolidation and deconsolidation of cargo; cargo clearance and documentation; the determination of alternate uses transport or interface cargo handling capacity; as well as for financial transactions.

The Port of New York and New Jersey and others have found success in promoting EDI systems that allow transportation carriers, shippers and forwarders to link up their data bases through a common communications base. Moreover, ports like Seattle and Singapore are beginning to take the lead in becoming conduits for international shipper data transfer. Finally, if EDI use is to reach its full potential, it must become more standardized, less complex, better understood and less expensive.

Role of the Public Sector

The effective nurturing and management of intermodal systems (and even additional technological improvements) cannot be fully accomplished by the private sector alone. The public sector—port authorities, federal agencies, state DOTs and local government—have responsibility for infrastructure maintenance, improvement and public safety necessary to support port transfer and landside access. States, in particular, have critical responsibilities for the management of port and rail highway access. If properly managed, additional growth in intermodal systems will help states relieve congestion,

minimize heavy truck wear and tear on their highways, improve utilization and investment in railroad rights-of-way and create new service synergies for domestic and international shippers.

The following recommendations can be addressed at the state level:

- increase states intermodal transportation management and planning capabilities;
- improve infrastructure that is crucial to intermodal efficiency and connectivity;
- create partnerships to test new intermodal services;
- help streamline intermodal regulations and policies;
- consider intermodal impacts in key transportation finance and policy debates.

Summary and Conclusion

Technological improvements in our intermodal transportation systems are adding a new and more flexible dimension to freight transportation services. Now it is possible to combine the best elements of a single mode system to produce new cost and quality choices. Ship-rail landbridge systems now compete against all water routes on the Asia to East Coast trade routes. Truck/rail intermodal systems offer alternatives to truck-only services over long distances. Indeed, the intermodal pipeline has become a main line service that will enjoy additional growth and improvement in the coming years.

As noted above, government policies and programs can help maintain and give shape to key elements of the intermodal pipeline. They can assist in producing more robust, multi-modal competition. In this new environment, the public sector contribution to intermodal development must be increased and skillfully directed to help make intermodal technologies and services "be all that they can be" to meet the shippers and their customers needs.

SPECIAL COMMITTEE ON INTERMODAL ISSUES

Public Policy Question Involving Long Combination Vehicles and the Railroad Industry

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The Norfolk Southern Corporation is one of the largest transportation companies in the United States, with about 15,000 miles of tracks and over 10,000 trucks represented in our North American Van Lines subsidiary. Our revenues from transportation activities are in excess of \$4 billion.

The topic today is Public Policy Questions involving Long Combination Vehicles and the Railroad Industry. It is a topic that has already evoked considerable rhetoric and emotion. Our task today is to strip away the subjective issues and to identify the real issues that the Public, the State Houses and the Federal Government ought to be interested in.

Unfortunately, *safety* has taken far and away the most time on the public agenda. Safety is an emotional issue and probably one that neither the trucking industry nor the railroad industry can address properly. We just don't have enough information on either side to let this question take the amount of time on the agenda that it has, so far, consumed.

Organizations, such as CRASH, have pointed out the safety hazards involved in Long Combination Vehicles. The trucking industry has responded with data that suggests that LCV's are actually safer than single trailer trucks.

What happens to the LCV after it gets off the major highway?

In point of fact, Long Combination Vehicles currently run on rather restricted routes. When they do, the companies that run them admittedly put their most experienced drivers on these runs so that the current experience is limited to a "best case" test tube-like environment. To take the current experience and to extrapolate from that what the likely results will be once these vehicles become ubiquitous is silly. Both sides are in error here for allowing the debate on this issue to get out of hand. Dramatic photographs of serious accidents with trucking company names prominently displayed are as in error as quoting accident rate statistics in this limited environment. If you take the truckers arguments to their logical extension then we should have trucks as long as trains, because that is what the statistics indicate.

Let us now turn to the issue of *Highway Infrastructure*. It is indisputable from the current studies that LCV's will require incremental investments in the current infrastructure. Whether they are twin

48-foot trailers or three 28-foot trailers, LCV's cannot be allowed everywhere. Even the trucking industry believes in restricting LCV access to major highways. There are three issues involved in this limited access problem that need to be clearly thought through:

1. Current super highway entrance and exit ramps are *not engineered for these vehicles*. Therefore changes will have to be made to each entry and exit ramp. How much will this cost? Who will pay? How much time will it take to re-engineer the inter-state and major state highway ramps for this utilization?
2. What happens to the LCV after it gets off the major highway? The answer is you need a "drop lot", where truckers can drop the multi-trailers and dray them to their ultimate location. How much will this cost? Who will pay for these? How much time will construction take?

In some urban areas there just isn't room for a drop lot. So now the questions are: How far can they go on local roads? What lucky local highway official will make that choice? How many decisions of this nature will have to be made?

3. Finally, what about the issues of enforcement? Who will measure these vehicles? Who will see to it that they remain on limited access highways? Obviously, once you compromise on short journeys off of the recognized system there will be pressure to expand the geography. Who will make those decisions?

We all know about the condition of our major highways today. Before we spend money on repairing the current problems, we will have to spend a lot of additional time and money re-engineering them to allow for LCV's. Are we stepping up to that issue or do we propose to deal with it after they are legalized?

As we pointed out before, highways were not designed for either the current truck configurations or the share of tonnage that they currently haul.

Now, forget for a moment the condition of the road beds on our major highways and think, if you will, about the problems of overcrowding.

First, a little history lesson. Today's interstate highway system was designed before the era of the big truck. In 1950 truck trailers were less than 35 feet long. The gross vehicle weights were less than 37 tons and, as a practical matter, very few trucks were designed to carry even that much in the early 1950's.

In 1950, 172,860,000,000 revenue freight tons moved on the highways. This was 16.3 percent of the total. The interstate highway system made trucking much more competitive with the rail industry and diverted more tonnage from rail to truck. By 1988 704,000,000,000 revenue freight tons were moving on the highways (more than four times the 1950 amount). And now they are moving in 53-foot trailers at more than 40 tons in some places. Truck share has grown by more than 50 percent to 25.2 percent of all revenue freight ton miles in 1988.

As we pointed out before, highways were not designed for either the current truck configurations or the share of tonnage that they currently haul. Is it any wonder, then, that the interstate system has worn out much more quickly than was expected?

What we are now asked to do is put bigger and heavier trucks on the highway. *By everyone's admission this will divert more freight from the rails.* So not only will the trucks be longer and heavier. There will be more of them because they will take freight from the railroads.

One of the truck lobby's pat answers in response to this is that highways are not generally congested or that the congestion on interstate "beltways" is a result of "local" traffic. In fact, every truck that moves between points west and north of Chicago and points east and north of Chicago ends up on route 80. The beltways of every city are choked with trucks that do not originate and terminate in that city. We are proposing to put longer and heavier trucks into the "beltway environment". Do we really want to do that?

We are told that the 1990's will be the "Green Decade". The Public is concerned about the environment, about pollution and waste. Here we have unambiguous data about the efficiencies and pollution levels of the different modes. The simple fact of the matter is that:

- Railroads generate 1/9 (11 percent) of the hydrocarbon emissions as trucks do per ton mile.
- Railroads generate 1/3 (33 percent) of the nitrous oxides as trucks per ton mile.
- Railroads use approximately 1/3 (33 percent) the diesel fuel that trucks do per ton mile.

Yet, we continue to see on the public record the trucking lobby complain about the railroads "standing in the way of efficiency". The LCV's, they say, are much more productive and efficient than current trucks. There is no question that this is true. However, there is also no question that *LCV's are only fractionally as efficient and as productive as current generation rail technology*. Somehow, this fact keeps getting overlooked in the decibel level of the public debate.

Let us now turn to today's railroad technologies and the competitive rate and service levels with trucks. One of the arguments used by truckers is that the railroads are not competitive with trucks in either rate and service and that the railroads' objections to LCV's are based on their inability to compete in a "fail competition" with the trucks.

The economies of stacking have allowed railroads to increase the share of long haul merchandise shipments using both rate and service to attract the shipper.

In fact, recent history indicates that the opposite is true. In the past two to three years railroads have picked up significant market share on international and transcontinental shipments with the use of double stack trains. These are rail cars which allow two containers (including 48- or 53-foot containers) to be "stacked" on top of each other on one platform. The economies of stacking have allowed railroads to increase the share of long haul merchandise shipments using both rate and service to attract the shipper.

We have also been able to use a new technology called "bimodal" or "carless" technology in shorter haul lanes. These "roadrainers" are operated in our Triple Crown Services subsidiary and they have successfully challenged truckers for "over the road" freight. From less than 4,000 revenue shipments in 1986, Triple Crown has grown to 106,000 loads in 1990. This shows that the truckload carriers can be challenged for shorter haul traffic as well as long hauls.

The point that we are attempting to make here is that Railroads can offer rate and service packages equal to truckers. As a matter of Public Policy it would seem from an infrastructure, from an overcrowding, from an efficiency and from a pollution, from a rate or service point of view the railroads are more than up to the competitive challenge of the truckers.

However, it is clear that the many issues surrounding LCV's have not been clearly articulated. Safety, although the single most important issue, is not and can not be accurately judged from existing data. It takes a considerable leap of faith to assume that bigger trucks in wide scale use by

every type of driver will not offer some type of enhanced public risk. By the same token, the railroads, with significant under-utilized capacity, could handle much more freight that is moving on the highways today without concomitant risk.

The Public Policy question becomes: Are we now prepared for the widespread legalization of long combination vehicles as proposed by the trucking industry? The answer is CLEARLY NOT!

Further: is the widespread use of long combination vehicles clearly in the public interest even if we were prepared? We submit that the answer is: NO!

The last unasked question becomes: Absent LCV's are the railroads up to the task of enhancing the country's competitive ability by further improving surface freight transportation? The answer is that the data indicates that we already are.

SPECIAL COMMITTEE ON TRANSPORTATION SYSTEMS OPERATION

IVHS in Minnesota: A State Perspective

RICHARD STEHR

Minnesota Department of Transportation

Introduction of Intelligent Vehicle Highway Systems (IVHS) in Minnesota started several years ago when the Minnesota Department of Transportation's (Mn/DOT's) new Commissioner, Leonard Levine, declared three top priorities for Mn/DOT: 1) stable, adequate funding, 2) safety for travelers and Mn/DOT employees, and 3) dealing with rapidly growing congestion in the Twin Cities of Minneapolis and St. Paul. Congestion currently costs Twin Cities motorists \$450 million per year, and the miles of congested freeways were projected to triple in the Twin Cities by the year 2000.

In the fall of 1988, the Commissioner declared a "Ten Point Plan" to deal with the congestion problem. This ten point plan, which was completed in 1989, included several demonstrations of new technology as well as a management plan for the rapidly expanding freeway operations program.

A Strategic Action Plan was also developed to continue the aggressive effort begun by the Commissioner's ten point plan. It continued rapid expansion of existing traffic management technology and motorist information services, and called for the rapid introduction of something only vaguely known as Intelligent Vehicle Highway Systems.

Dick Braun at the University of Minnesota, Center for Transportation Studies was actively involved in defining IVHS through Mobility 2000. Working with the Center for Transportation Studies, Mn/

DOT launched a program named GUIDESTAR to guide the way to these highways of the future.

Mobility 2000 had identified the kinds of systems involved in IVHS,

- Advanced Traffic Management Systems
- Advanced Traveler Information Systems
- Advanced Vehicle Control Systems
- Commercial Vehicle Applications

Mn/DOT already had well established programs for traffic management and motorist information. Mn/DOT was also a participating in the H.E.L.P. program for applying advanced technology to commercial trucking, and projects within the state were underway to develop expert systems to route overweight/over-dimension trucks.

Current Minnesota activities were reviewed in each of these areas of IVHS and a vision formed for GUIDESTAR that included research projects, development of emerging technology, field demonstrations and rapid deployment.

The Mn/DOT Vision

In December of 1989, a goal was declared to establish the public infrastructure for IVHS for the entire 268 mile Twin Cities Freeway System by 1995. The public infrastructure was to provide everything needed to support the vehicles of the future.

This infrastructure would include systems that monitor traffic through sensors, cameras, and roadside communications. The need was identified for a central or roadside communication system to provide information to vehicle guidance systems, whether that is people or computers, so congestion could be avoided. These systems needed to be compatible with and supportive of private systems in the vehicles.

The emphasis of this vision is to collect information from every source possible into an information pool and do three things: first, provide direct system controls and corridor management through signal lights and lane closings; second, provide motorist information through CMS, or highway advisory broadcasts; and third, provide incident management through deploying incident response vehicles and equipment.

The GUIDESTAR program aims at breakthroughs in each of the key areas of these functions: data collection, data analysis and decision making, and driver guidance and information systems.

Current Status

In Minnesota there is already a successful system of ramp meters, camera surveillance, and pavement loop detectors that monitor traffic. This is managed from a central control building in downtown Minneapolis called the Traffic Management Center (TMC). Additional monitoring and computer control equipment has been easily and rapidly added inside this building.

Ramp metering has been expanded from 66 ramps in December, 1988, to 126 ramps today. By the end of this year 205 ramps will be metered. Many ramp meters are initially installed to work on time clocks to quickly capture a big share of the benefits that come with metering. Camera surveillance, roadway sensors, and real-time centralized computer control to link these ramp meters into our system are being added as the fibre optic communication system is put in place.

New Technology, Data Collection

GUIDESTAR attempts to push beyond current technology in each area. In data collection, for instance, Mn/DOT was already well along in a six-year development program for "smart cameras" with the Center for Transportation Studies.

The "smart camera" invention called Autoscope, patented at the University of Minnesota, uses image processing technology to detect vehicles. Through a simple use of a mouse, lines can be placed across freeway lanes or ramps which are displayed on a TV screen and any vehicles crossing that line are counted. This technology can replace loops in the pavement allowing quick and easy addition of monitoring points along an individual lane, on shoulders, or at ramps and intersections.

Autoscope also allows saving of the data and the visual record if an accident occurs. This will be useful for traffic engineering studies, and perhaps even tort litigation studies. This is similar to the way banks use cameras to record robberies. The next challenge is to develop expert systems so the camera will be able to recognize when special incidents occur, alert system operators, and save the video record of the event.

Expert Systems

Expert systems are considered critical for GUIDESTAR in the analysis and decision making functions for Advanced Traffic Management Systems.

Minnesota has events such as snow, ice, and rainstorms which trigger many simultaneous incidents. Even with the current limited system of cameras, changeable message signs, ramp meters, and traffic radio signs, handling a half dozen simultaneous incidents during a snow or ice storm is extremely difficult. When the system expands to 300 cameras, 60 changeable message signs, and a broad array of motorist information systems it will become impossible to manage these events without expert systems.

The GUIDESTAR program focuses on three areas to develop expert systems. The first area is real-time simulation models to help predict where congestion is going to occur and then computer adjust metering rates to prevent it. Rapid simulation will also help evaluate and recommend strategies when dealing with incidents. In the second area is software that will enable Autoscope to identify when an incident has occurred. The third focus area is expert systems to assist in managing an incident once it is detected.

Traveler Information Systems

Minnesota also launched projects in the traveler information area of IVHS. A contract with the Minneapolis Public School System allows Mn/DOT to use their FM radio station "KBEM" for traffic broadcasts. The broadcaster sits in the TMC during rush hours and reports on traffic every ten minutes. In the event of an incident, the broadcast is continuous until the incident is cleared.

Signs supporting the traffic radio broadcasts have been installed along the freeways which say "Traffic Radio 88.5 FM When Flashing". Lights on these signs begin flashing when an incident is detected downstream. Twenty-seven such signs have been installed on freeways at locations where camera surveillance can verify incidents. They can be individually turned on or turned on in groups by a radio signal from the TMC. This system of signs allows motorists to only tune in to traffic radio when the information directly affects them. This system proved extremely valuable in managing the recent visit of President Gorbachev when major interstate segments were closed for a half hour or longer.

Under development are network graphic displays of traffic conditions on streets and freeways. These graphics will be broadcast to TV monitors in public and private parking ramps in order to divert motorists from congested freeways before they even leave their ramps.

IVHS Strategy

Minnesota's strategy is not to incrementally deploy new technology as it develops and only install it on new freeway corridors when they are reconstructed for other reasons. Instead, the plan is to design and implement an entire metro-wide system by 1995. Many benefits of IVHS cannot be realized by only dealing with isolated corridors. Future upgrades to this IVHS system will then also be planned "system-wide".

The pre-engineering and design of major system components has already begun. The initial costs are primarily government costs for the infrastructure. Implementation will eventually involve a substantial private sector investment for equipment in vehicles. A Management Consultant has been hired to review the current GUIDESTAR program, and to help plan the final design, testing, and evaluation of additional components.

Key to the public infrastructure side is the communication system. This system must bring camera surveillance and traffic data into a central point and allow communicating back to the vehicles through several possible technologies. The overall network design for a fibre optic communication system has been completed and the detailed design for Phase I of this system has begun. Through a series of four contracts a 300 mile freeway and arterial system should be completed and operational by 1995. This system will tie the ramp meters into central computer control and add vehicle detection equipment and camera surveillance. It will also be capable of carrying communications to and from roadside beacons that communicate with vehicles.

IVHS Laboratory

Another key feature of Mn/DOT's program is the creation of an IVHS laboratory on Interstate 394 for testing new technology. This 3 1/2-mile corridor, with a dense deployment of traditional loops and Autoscope data collection equipment, will provide a database of unprecedented richness for researchers to test and evaluate equipment and theories.

Public/Private Partnership

GUIDESTAR participants currently include Mn/DOT, the Center for Transportation Studies, and the FHWA. A key to the success of the program will be private sector participation.

Without some means for rapid development and deployment of in-vehicle devices, the system will not achieve its full benefits. Fourteen companies have expressed interest in this part of our program. We are preparing a request for proposals to help fill the traveler communication gap in our 1995 system and we are optimistic it can be done.

Benefits

The benefits of IVHS are substantial. Advanced Transportation Management Systems alone have achieved remarkable successes on Minnesota freeways in reducing accident rates by about 30 to 40 percent. Mobility has also remarkably increased during peak travel periods on controlled corridors with peak hour speeds increasing by about 35 percent.

Summary

Mn/DOT has successfully started an IVHS program that will lead to an operational IVHS system by 1995. This system will include more than 300 miles of freeways and arterials. The area wide approach to rapid implementation of a broad spectrum of IVHS technologies is unique. It should make the Twin Cities a showcase for IVHS by 1995.

REPORTS FROM THE AASHTO TASK FORCE ON A CONSENSUS TRANSPORTATION PROGRAM

- **Proposed Formula Factors for Allocating Federal Highway Funds**
- **Alternate Financial Formulas for Allocating Federal Highway Funds**
- **Discussion on the Use and Taxation of Alternate Fuels in the Future**

The following reports were prepared for the AASHTO Task Force on a Consensus Transportation Program by the Task Force's Policy Review Committee, and were accepted by the Task Force on December 6, 1990, to be forwarded for information purposes to the member departments of AASHTO.

Each of these documents deals with an aspect of the implementation of the principles set forth in the "New Transportation Concepts for a New Century" report prepared by AASHTO to provide recommendations on the reauthorization of the federal surface transportation program.

The documents address the following issues assigned to the Policy Review Committee and its various subcommittees by the Task Force and the Policy Committee of AASHTO:

- "Proposed Formula Factor For Allocating Federal Highway Funds"...Addresses which factors appear to be the best quantifiers of highway system extent and use.
- "Sample Formulas For Allocating Federal Highway Funds"...Presents sample formulas along with the current FHWA formula and a listing of the pros and cons for each option. Concerns over how the gasohol exemption and the bridge needs might be addressed by the formulas are also presented.
- "Discussion On The Use and Taxation of Alternate Fuels In The Future"...Explores issues concerning the future expansion of the use of alternate fuels and future problems associated with revenue collection.

Proposed Formula Factors for Allocating Federal Highway Funds

The Policy Review Committee has considered several factors for possible use in the formulas for distributing federal funds to the states. Several of the factors considered are now being used; several others might be used in the future.

At its September 6 meeting in Minneapolis, the PRC made a preliminary evaluation of the factors considered based on the uniformity and accuracy of the underlying data and the appropriateness of the factor as a basis for distributing funds. The PRC ranked twenty factors according to appropriateness. Six factors were considered "more appropriate." Three factors were considered "appropriate." The remaining factors were considered "less appropriate."

At its November 7 meeting in Phoenix, the PRC reviewed and approved a preliminary draft of this report. That draft was prepared as a cooperative effort by the staffs of the California Department of Transportation and the Texas Department of Highways and Public Transportation.

This report considers only those nine factors that were considered "more appropriate" or "appropriate." The factors are considered in the order of their "appropriateness" ranking by the PRC.

The Appendix contains a glossary of terms used in the discussion of the various factors. It also contains materials discussing several of the less appropriate factors. Except for the addition of a discussion of state population, the material dealing with the less appropriate factors has not been revised since the September PRC meeting.

More Appropriate Factors

Highways — Lane Miles Of Roadway

Nature

Measures extent of public roads in both rural and urban areas.

Type of Measure: Direct or Surrogate

Direct.

Accuracy And By Whom Verified

Probably the simplest and most efficient potential apportionment factor on which to obtain accurate information. However, FHWA believes accuracy could be further improved.

For all functional systems other than local, information is based on estimates from HPMS data. Any sample-based data collection system involves statistical imprecision, particularly in conclusions about the absolute value of any condition rather than relative changes.

More difficult to develop lane mile data on urban system because of particular urban characteristics, such as existence of parking and turning lanes.

FHWA prepares the estimates.

For urban and rural roads functionally classified as local, data may be reasonably estimated by multiplying centerline mileage (which is available) by 2.

Validity

As a Measure of Highway Extent and Use:
Measure of system extent, but not related to system use. Relevant and meaningful as a basis for

apportioning authorizations to preserve current highway system. Reflects the extent of the system to be preserved. Better measure of extent of road network than land area.

As a Measure of Future Highway Needs: No relevance or meaning.

Timeliness or Currency

Annual data are generally available within 6 to 9 months of the close of the calendar year to which they relate.

Sensitivity

Between 1987 and 1988, the number of lane miles for all functional systems in the United States increased by 0.03 percent. The greatest increase in lane miles within any single state was 3.85 percent in Florida. The greatest decrease was 15.5 percent in Idaho.

The average change in a state's percentage share of total national lane miles was zero. No state's share increased or decreased by more than 0.3 percent. The greatest variation was in Idaho, with a decrease of 0.27 percent (over 4 standard deviations). The next greatest variation was in Texas, with an increase of 0.18 percent (over 3 standard deviations). Utah's lane mileage share decrease by 0.17 percent, and Arizona's, by 0.15 percent (both between 2 and 3 standard deviations). All other states were within 2 standard deviations of the average.

Uniformity

Available for public roads only. Available for all functional systems except "Local." (Data for local systems may be reasonably estimated.) Segregated by Rural and Urban. Data also segregated for Interstate highways and for non-Interstate Federal-Aid Primary highways.

By Whom Collected

Source data for Interstate, primary, secondary, and urban highways collected jointly by FHWA and the states.

How Collected

Source data for Interstate, primary, secondary, and urban highways collected through HPMS. Local functional system data must be estimated. Non-public road data not available.

How Raw Data is Translated

FHWA estimates lane mileage from HPMS data.

Number of lanes per section multiplied by the actual length of the section. For example, a four-lane section that is 2 miles long would be equivalent to 8 lane miles.

Susceptibility to Manipulation

Minimal if measure is applied to all public roads. Moderately low if applied to public roads of a particular functional classification. Moderately high if measure applied to roads under the jurisdiction of state or of local governments. High if measure is applied to public roads on or off the federal-aid system.

Effectiveness as Incentive to Effective and Efficient System Management

If apportionment factor was based on all public roads, would not bias investment decisions. If apportionment factor was based on less than the full highway network, whether certain mileage was or could be included in the factor basis could drive investment decisions.

Appropriateness of Use in Combination with Other Factors

Should be used only in combination with measures of system use to more accurately reflect preservation needs, and to reflect future needs.

References

1. Federal Highway Administration, *Highway Statistics 1988*, Tables HM-20, HM-60.
2. United States General Accounting Office, *Highway Funding: Federal Distribution Formulas Should Be Changed*, (Report to the Honorable Lawton Chiles, U.S. Senate, March 1986)

Bridges—Bridge Area

Nature

Measure of capital stock.

Type of Measure: Direct or Surrogate

Direct.

Accuracy And By Whom Verified

The National Bridge Inventory is based on inaccurate, incomplete, and inconsistent state bridge data. The state bridge data included are not adequately verified by FHWA.

Validity

Relationship to Highway Extent and Use: Appropriate factor to reflect the extent of the bridge stock to be preserved. Some relationship to capacity. No relationship to use.

Relationship to Future Highway Needs: N/A

Timeliness or Currency

Collected at least every 2 years.

Sensitivity

N/A

Uniformity

N/A

By Whom Collected

Collected by states; provided to FHWA

How Collected

Collected by states through periodic bridge inventory process.

How Raw Data Is Translated

N/A

Susceptibility to Manipulation

Minimal if measure is applied to all bridges. Moderately low if applied to bridges on roadways of a particular functional classification. Moderately high if measure applied to bridges under the jurisdiction of state or of local governments. High if measure is applied to bridges on or off the federal-aid system.

Effectiveness as Incentive to Effective and Efficient System Management

If apportionment factor was based on all bridges, would not bias investment decisions. If apportionment factor was based on less than all bridges, whether certain bridges were or could be included in the factor basis could drive investment decisions.

Appropriateness of Use in Combination with Other Factors

Should be used only in combination with measures of use to more accurately reflect preservation needs, and to reflect future needs.

References

1. Federal Highway Administration, *National Bridge Inventory*
2. United States General Accounting Office, *Highway Funding: Federal Distribution Formulas Should Be Changed*, (Report to the Honorable Lawton Chiles, U.S. Senate, March 1986)
3. United States General Accounting Office, *Bridge Condition Assessment: Inaccurate Data May Cause Inequities in the Apportionment of Federal-Aid Funding*, (Report to Congressional Requesters, May 1988)
4. Report of the Secretary of Transportation to the United States Congress, *The Status of the Nation's Highways and Bridges: Conditions and Performance and Highway Bridge Replacement and Rehabilitation Program 1989* (June 1989)

Highways—Population Density—Low Density States

Nature

Indicates use in urban states. Suggests capital stock needs in rural states.

Type of Measure: Direct or Surrogate

Surrogate for use (urban) and extent (rural).

Accuracy

Varies with the frequency of population updates, urban land boundary changes, and methods for determining land area.

Validity

Relationship to Highway Extent and Use: Population density relates primarily to use of highway system in urban states. However, low density states

located between high density states could have high use on connecting roadways.

Relationship to Future Highway Needs: Relates to both preservation of the existing system and the need for new construction.

Timeliness or Currency

Population may be estimated between decennial censuses. Decennial census data would not be current. Federal-aid urban boundaries may change between decennial census estimates.

Sensitivity

Between 1987 and 1988, population density in the United States increased by 0.67 people per square mile. The District of Columbia's population decreased by 79.37 people per square mile. The greatest increase in population density within any single state (excluding the District of Columbia) was in Maryland, which gained 8.32 people per square mile. The greatest decrease was in Louisiana, which lost 1.1 people per square mile.

When each state's rate of increase or decrease is compared to the 0.67 people per square mile increase in the national population density, no state's population density (including that of the District of Columbia) increased or decreased by more than 5 times the national rate of increase. The greatest rate of increase was in Nevada, which increased its density at a rate 4.67 times the national rate of increase (over 3 standard deviations). The greatest rate of decrease was in Wyoming, which decreased its density at a rate 2.24 times the national rate of increase (over 2 standard deviations). All other states were within 2 standard deviations of the national rate of increase.

Uniformity

Through the HPMS, states provide statewide urban and rural land area and population data to FHWA. Methods for land area determination and frequency of population estimates may vary among states.

By Whom Collected

States Collect.

How Collected

Methods for estimating updated population and land areas may vary among states.

How Raw Data Is Translated

N/A

Susceptibility to Manipulation

Manipulation or misinterpretation could occur if urban-rural boundaries are not delineated correctly.

Effectiveness as Incentive to Effective and Efficient System Management

Allocation based on population density could act as incentive to using funds for traffic efficiency improvements in urban areas. With proper legislative language, the population density factor could be effective in promoting transit improvements.

Appropriateness of Use in Combination with Other Factors

Population density should be used in combination with factors such as motor fuel consumption and lane miles for balance and to ensure that those who contribute to federal trust fund are accounted for.

When basic apportionment formulas are based on other factors, population density could be used to adjust apportionments for states whose apportionments fall substantially below FY 1990 apportionment levels, or fall below a minimum percent of the percentage of estimated contributions to the Highway Trust Fund.

No state has a population density that is less than the population density of the nation by more than 0.75 standard deviations.

The population density of the District of Columbia, a single urban district, is more than 140 times the population density of the United States. Excluding the District of Columbia, however, only four states have a population density significantly greater than that of the nation as a whole. The population density of the New Jersey is over 14.5 times (more than 4 standard deviations) the population density of the United States. The population density of Rhode Island is over 12 times (more than 3 standard deviations) the population density of the United States. The population densities of Massachusetts (over 10 times the population density of the United States) and Connecticut (over 9 times the population density of the United States) are more than 2 standard deviations greater than the population density of the United States as a whole. No other states have population densities that is greater than the population density of the nation by more than two standard deviations.

References

1. Federal Highway Administration, *Highway Statistics 1988*, Table DL-1B.
2. Bureau of the Census, U.S. Department of Commerce, *Statistical Abstract of the United States 1989*, Table 331.

Highways — Vehicle Miles Traveled —Total

Nature

Measure of traffic per route mile

Type of Measure: Direct or Surrogate

Direct

Accuracy And By Whom Verified

Sample or estimated data from HPMS. The HPMS panels of sections have been statistically designed for a high level of measurable accuracy.

FHWA divisions review for accuracy.

Average daily traffic for roadways classified as "Local" is estimated. The method of estimating may vary from state to state.

Validity

Relationship to Highway Extent and Use: Direct relationship: useful for estimating travel time, fuel consumption, emissions, people and freight movement and maintenance practices and revenue projections. Factor would favor more populous states.

Relationship to Future Highway Needs: Relates to both capital improvement and system preservation needs. Factor would favor more populous states.

Timeliness or Currency

Data is collected continually and submitted annually.

Sensitivity

Between 1987 and 1988, total vehicle miles traveled in the United States increased by 5.26 percent. The greatest increase in vehicle miles traveled within any single state was 15.87 percent in Indiana. The greatest decrease was 2.66 percent in Delaware.

The average change in a state's percentage share of total national vehicle miles traveled was zero. No state's share increased or decreased by more than 0.3 percent. The greatest variation was in Florida, with an increase of 0.33 percent (over 4 standard deviations). The next greatest variations were in Indiana, with an increase of 0.23 percent, and in California, with an increase of 0.17 percent (over 2 standard deviations). All other states were within 2 standard deviations of the average. Texas had the greatest decrease (0.13 percent) in its percentage share of the national total.

Uniformity

All state DOTs are required by HPMS to provide VMT data by functional system. Standard HPMS methodology used in all states. FHWA divisions review for accuracy and take corrective actions as necessary to ensure compliance with requirements.

Average daily traffic for roadways classified as "Local" is estimated. The method of estimating may vary from state to state. For all cities, counties, and states to make uniform traffic counts would require new FHWA guidelines. This would require substantial additional resources and the cooperation of state and local highway agencies.

By Whom Collected

State highway agencies in cooperation with local governmental units, metropolitan planning organizations and other organizations.

How Collected

Development of HPMS estimates of highway travel by functional system are derived using count-based traffic data that are in concert with the *HPMS Field Manual* and *Traffic Monitoring Guide*.

How Raw Data Is Translated

In various manners depending on source and frequency of observations, all data is edited by the state HPMS staff before entering into the database.

Susceptibility to Manipulation

Low due to monitoring guidelines.

Effectiveness as Incentive to Effective and Efficient System Management

Not as effective towards efficiency as a factor related to people moved rather than vehicles moved. Does not account for different vehicle classifications.

Appropriateness of Use in Combination with Other Factors

Should be used in combination with lane miles and diesel fuel consumption to achieve a balanced allocation of funds relating to both use and extent of the system.

References

1. Federal Highway Administration, *Highway Statistics 1988*, Table VM-2.
2. United States General Accounting Office, *Highway Funding: Federal Distribution Formulas Should Be Changed*, (Report to the Honorable Lawton Chiles, U.S. Senate, March 1986)

Highways—Motor Fuel Consumption—Diesel

Nature

Measure of highway use, especially by heavy trucks.

Type of Measure: Direct or Surrogate

Surrogate

Accuracy And By Whom Verified

"Special fuel" consumption data are published by FHWA based on information submitted by the states. As reported by the states and published by FHWA, "special fuels" consist primarily of diesel fuel with small amounts of liquefied petroleum gases.

Reflect travel on all roads, not just those on the federal-aid system or those under state jurisdiction.

Diesel fuel is taxed in most states at the location it is placed in a vehicle's tank or at the first point of sale for highway use. Thus, the data reported by the states represents highway use, and does not require adjustments by FHWA.

An unknown amount of fuel tax evasion is believed to occur. Because tax collections form the basis for estimating consumption, tax evasion reduces reported consumption. Tax evasion is believed to be more extensive in diesel sales. Diesel fuel tax collection is more difficult to oversee for several reasons: (1) diesel fuel taxes are collected at the retail level; and (2) home heating fuel, which is normally not taxed, may be used as diesel fuel.

Validity

Relationship to Highway Extent and Use: No relationship to highway extent. Reflects intensity of highway usage, especially by heavy trucks.

Relationship to Future Highway Needs: Highway usage, along with factors such as weather and time, determines highway deterioration. Thus, can be used to reflect highway preservation requirement.

Timeliness or Currency

Data are reported by state fuel tax agencies monthly, and adjusted at year end. Annual data are generally available within 6 to 9 months of the close of the calendar year to which it relates.

Sensitivity

Largely determined by vehicle miles traveled and motor vehicle fuel efficiency.

Between 1987 and 1988, diesel fuel consumption in the United States increased by 5.4 percent. The greatest increase in diesel fuel consumption within any single state was 49.06 percent in Alaska. The greatest decrease was 21.36 percent in Rhode Island.

The average change in a state's percentage share of total national diesel fuel consumption was zero. No state's share increased or decreased by more than 0.7 percent. The greatest variation was in Kentucky, with an increase of 0.68 percent (over 4 standard deviations). The next greatest variation was in Texas, with a decrease of 0.67 percent (over

3 standard deviations). All other states were within 2 standard deviations of the average.

Uniformity

Fuel consumption patterns across states may differ because of such factors as the relative urban-rural population mix, relative amount of travel done under congested conditions, relative differences in physical terrain, and transient fuel purchases in states with lower fuel tax.

By Whom Collected

State motor fuel tax agencies receive reports of diesel fuel tax collections, generally from diesel fuel retailers. "Special fuel" consumption data are published by FHWA based on information submitted by the states. "Special fuels" consist primarily of diesel fuel with small amounts of liquefied petroleum gases.

How Collected

By state motor fuel tax agencies, generally from diesel fuel retailers.

How Raw Data is Translated

Compiled by FHWA based on summaries prepared by the state motor fuel tax agencies from reports submitted to them by diesel fuel retailers.

Susceptibility to Manipulation

N/A

Effectiveness as Incentive to Effective and Efficient System Management

N/A

Appropriateness of Use in Combination with Other Factors

Should be used only in combination with measures of system extent to more accurately reflect preservation needs. Should be used only in combi-

nation with measures of system use by conventional traffic.

References

1. Federal Highway Administration, *Highway Statistic 1988*, Table MF-25.
2. United States General Accounting Office, *Highway Funding: Federal Distribution Formulas Should Be Changed* (Report to the Honorable Lawton Chiles, U.S. Senate, March 1986)

Highways—Vehicle Miles Traveled—Trucks

Nature

Measures of use.

Type of Measure: Direct or Surrogate

Direct measure of traffic activity.

Accuracy And By Whom Verified

Truck registration data reported by FHWA includes light trucks to the extent they can be identified and separated from automobiles. It is not yet possible to obtain from all states separate data on single-unit trucks and combinations. Some states provide data for light trucks and truck tractors, but for many states FHWA estimates this information using other data sources (*e.g.*, the Truck Inventory and Use Survey conducted by the Bureau of the Census). FHWA segregates data for pickups, panels, and delivery vans generally of 10,000 pounds or less gross vehicle weight into a separate "Light Trucks" column.

Most automatic counters use length between axles and do not measure axle weight; light vehicles such as motor homes towing trailers can register as heavy trucks. Weigh in motion technology will improve accuracy.

FHWA reviews each state's methodology for consistency with HPMS standards.

Validity

Relationship to Highway Extent and Use: Direct relationship: useful for estimating travel time, fuel consumption, emissions, people and freight movement and maintenance practices and revenue projections.

Relationship to Future Highway Needs: Relates to both capital improvement and system preservation needs. Trucks are believed responsible for a relatively high share of highway damage. Truck travel is used in pavement deterioration models to estimate future needs of the highway system.

Timeliness or Currency

Minimum criteria call for updating data every three years. Some states update more frequently. FHWA outlines procedures.

Data actually not readily available. Interstate truck operators are required to report mileage driven in each state, but reporting is on "honor system," with little enforcement.

Sensitivity

N/A

Uniformity

All states collect and report data through HPMS methodology.

By Whom Collected

State DOT's; some cities and counties may also collect and report data to the state DOT. HPMS requires state DOT's to report statewide data to FHWA on a sampling of all arterial and collector public roads.

How Collected

Truck counts are made on a sampling basis. Truck miles of travel on each highway sample are computed by multiplying the percent of trucks by the ADT by the sample length.

Interstate truck operators are required to report mileage driven in each state, but reporting is on "honor system," with little enforcement.

How Raw Data Is Translated

Factors are used to compensate for the day of the week and season of the year that sample data is taken.

Susceptibility to Manipulation

States could manipulate to show higher truck travel—FHWA would have to police data reported.

Effectiveness as Incentive to Effective and Efficient System Management

Could be useful in determining need for truck-only lanes or for truck operating schedules (truck bans), and in predicting future resurfacing and reconstruction needs.

Appropriateness of Use in Combination with Other Factors

Very appropriate because truck travel is important to economy and adds much cost to maintaining the highway systems.

References

N/A

Appropriate Factors

Highways—Centerline Miles of Roadway

Nature

Relates to the highway network physical plant. Covers both rural and urban areas.

Type of Measure: Direct or Surrogate

Direct

Accuracy And By Whom Verified

Simple to obtain accurate information.

FHWA expands from HPMS sample data from states. Because of the procedures used to factor summary HPMS data to nationwide levels, individual data components in various categorizations may not be compatible.

Validity

Relationship to Highway Extent and Use: To some extent, reflect the extent of the system. Perhaps a better measure of extent of road network than land area.

Relationship to Future Highway Needs: N/A

Timeliness or Currency

Annual data are generally available within 6 to 9 months of the close of the calendar year to which they relate.

Sensitivity

Between 1987 and 1988, the number of centerline miles in the United States decreased by 0.07 percent. The greatest increase in centerline miles within any single state was 4.15 percent in Florida. The greatest decrease was 15.32 percent in Idaho.

The average change in a state's percentage share of total national centerline miles was zero. No state's

share increased or decreased by more than 0.18 percent. The greatest variation was in Texas, with an increase of 0.18 percent, and in Nevada, with a decrease of 0.18 percent. Texas, Idaho, and Arizona increased their centerline miles by over 2 standard deviations. Nevada, Virginia, and South Carolina decreased their centerline miles by over 2 standard deviations. All other states were within 2 standard deviations of the average.

Uniformity

Available for public roads only. Classified by jurisdiction, by federal-aid or nonfederal-aid system, and by functional system. Federal-aid system data classified by type of surface, by lane width, by number of traffic lanes, by access control, and by average daily traffic volume. Segregated by Rural and Urban.

By Whom Collected

Source data collected jointly by FHWA and the states.

How Collected

Source data collected through the Highway Performance Monitoring System for Interstate, primary, secondary, and urban highways. FHWA estimates the distribution of local functional system surface types. Limited surface-type area-wide data is reported for local functional systems. That data is factored by FHWA to obtain total mileage.

How Raw Data is Translated

Data are expanded from HPMS samples for arterials and collectors from state reports.

Equals the actual length of the section, regardless of number of lanes. For example, both a two-lane section that is 2 miles long and four-lane section that is 2 miles long would be counted equally at 2 centerline miles.

Susceptibility to Manipulation

Minimal if measure is applied to all public roads. Moderately low if applied to public roads of a particular functional classification. Moderately high if measure applied to roads under the jurisdiction of state or of local governments. High if measure is applied to public roads on or off the federal-aid system.

Effectiveness as Incentive to Effective and Efficient System Management

If apportionment factor was based on all public roads, would not bias investment decisions. If apportionment factor was based on less than the full highway network, whether certain mileage was or could be included in the factor basis could drive investment decisions.

Appropriateness of Use in Combination with Other Factors

Should be used only in combination with measures of system use to more accurately reflect preservation needs, and to reflect future needs.

References

1. Federal Highway Administration, *Highway Statistics 1988*, Table HM-20
2. United States General Accounting Office, *Highway Funding: Federal Distribution Formulas Should Be Changed*, (Report to the Honorable Lawton Chiles, U.S. Senate, March 1986)

Highways—Population Density— High Density States

Nature

Indicates use in urban states. Suggests capital stock needs in rural states.

Type of Measure: Direct or Surrogate

Surrogate for use (urban) and extent (rural).

Accuracy And By Whom Verified

Varies with the frequency of population updates and urban land boundary changes and methods for determining land area.

Validity

Relationship to Highway Extent and Use: Population density relates primarily to use of highway system in urban states. However, low density states located between high density states could have high use on connecting roadways.

Relationship to Future Highway Needs: Relates to both preservation of the existing system and the need for new construction.

Timeliness or Currency

Population may be estimated between decennial censuses. Decennial census data would not be current. Federal-aid urban boundaries may change between decennial census estimates.

Sensitivity

Between 1987 and 1988, population density in the United States increased by 0.67 people per square mile. The District of Columbia's population decreased by 79.37 people per square mile. The greatest increase in population density within any single state (excluding the District of Columbia) was in Maryland, which gained 8.32 people per square mile. The greatest decrease was in Louisiana, which lost 1.1 people per square mile.

When each state's rate of increase or decrease is compared to the 0.67 people per square mile increase in the national population density, no state's population density (including that of the District of Columbia) increased or decreased by more than 5 times the national rate of increase. The greatest rate of increase was in Nevada, which increased its

density at a rate 4.67 times the national rate of increase (over 3 standard deviations). The greatest rate of decrease was in Wyoming, which decreased its density at a rate 2.24 times the national rate of increase (over 2 standard deviations). All other states were within 2 standard deviations of the national rate of increase.

Uniformity

Through the HPMS, states provide statewide, urban and rural land area and population data to FHWA. Methods for land area determination and frequency of population estimates may vary among states.

By Whom Collected

States collect.

How Collected

Methods for estimating updated population and land areas may vary among states.

How Raw Data Is Translated

N/A

Susceptibility to Manipulation

Manipulation or misinterpretation could occur if urban-rural boundaries are not delineated correctly.

Effectiveness as Incentive to Effective and Efficient System Management

Allocation based on population density could act as incentive to using funds for traffic efficiency improvements in urban areas. With proper legislative language, the population density factor could be effective in promoting transit improvements.

Appropriateness of Use in Combination with Other Factors

Population density should be used in combination with factors such as motor fuel consumption

and lane miles for balance and to ensure that those who contribute to federal trust fund are accounted for.

When basic apportionment formulas are based on other factors, population density could be used to adjust apportionments for states whose apportionments fall substantially below FY 1990 apportionment levels, or fall below a minimum percent of the percentage of estimated contributions to the Highway Trust Fund.

The population density of the District of Columbia, a single urban district, is more than 140 times the population density of the United States. Excluding the District of Columbia, however, only four states have a population density that is significantly greater than that of the nation as a whole. The population density of New Jersey is over 14.5 times (more than 4 standard deviations) the population density of the United States. The population density of Rhode Island is over 12 times (more than 3 standard deviations) the population density of the United States. The population densities of Massachusetts (over 10 times the population density of the United States) and Connecticut (over 9 times the population density of the United States) are more than 2 standard deviations greater than the population density of the United States as a whole. No other states have population densities that is greater than the population density of the nation by more than two standard deviations.

No state has a population density that is less than the population density of the nation by more than 0.75 standard deviations.

References

1. Federal Highway Administration, *Highway Statistics 1988*, Table DL-1B.
2. Bureau of the Census, U.S. Department of Commerce, *Statistical Abstract of the United States 1989*, Table 331

Highways—Motor Fuel Consumption—Total

Nature

Measure of highway use.

Type of Measure: Direct or Surrogate

Surrogate

Accuracy And By Whom Verified

Based on reports from state motor fuel agencies.

FHWA estimates public use and non-highway use.

Because of changes in data analysis or reporting procedures in some states, data from prior years are not comparable.

Reflect travel on all roads, not just those on the federal-aid system or those under state jurisdiction.

Data published by FHWA includes gasohol with gasoline, but gasohol use data is also reported separately.

Non-highway gasoline use data are not complete for some states. When that is the case, FHWA estimates those data.

An unknown amount of fuel tax evasion is believed to occur. Because tax collections form the basis for estimating consumption, tax evasion reduces reported consumption.

Validity

Relationship to Highway Extent and Use: Reflects intensity of road usage.

Relationship to Future Highway Needs: Road usage, along with factors such as weather and time, determines highway deterioration. Thus, can be used to reflect highway preservation requirement.

Timeliness or Currency

Data are reported by state fuel tax agencies monthly, and adjusted at year end. Annual data are generally available within 6 to 9 months of the close of the calendar year to which it relates.

Sensitivity

Largely determined by vehicle miles traveled and motor vehicle fuel efficiency.

Between 1987 and 1988, total motor fuel consumption in the United States decreased by 1.49 percent. The greatest decrease in total motor fuel consumption within any single state was 12.01 percent in North Dakota. The greatest increase was 5.75 percent in Kentucky.

The average change in a state's percentage share of total national motor fuel consumption was zero. No state's share increased or decreased by more than 0.35 percent. The greatest variation was in New York, with a decrease of 0.35 percent (the only state in which the variance exceeded 3 standard deviations). The next greatest variation was in California, with an increase of 0.22 percent. California and Illinois were the only two states in which the increase in percentage share exceeded 2 standard deviations. New York and Texas were the only two states in which the decrease exceeded 2 standard deviations. All other states were within 2 standard deviations of the average.

Uniformity

Non-highway gasoline use data are not complete for some states. When that is the case, FHWA estimates those data.

Fuel consumption patterns across states may differ because of such factors as the urban-rural population mix, amount of travel done under congested conditions, differences in physical terrain, and transient fuel purchases in states with lower fuel tax.

By Whom Collected

State motor fuel tax agencies receive reports of gasoline tax collections, generally from wholesale gasoline distributors. Gasoline consumption data are published by FHWA based on information submitted by the states.

How Collected

State motor fuel tax agencies receive reports of gasoline tax collections, generally from wholesale gasoline distributors. Gasoline consumption data are published by FHWA based on information submitted by the states.

How Raw Data Is Translated

Compiled by FHWA based on summaries prepared by the state motor fuel tax agencies from reports submitted to them by wholesale gasoline distributors. FHWA calculates highway gasoline use by subtracting non-highway use.

Susceptibility to Manipulation

N/A

Effectiveness as Incentive to Effective and Efficient System Management

N/A

Appropriateness of Use in Combination with Other Factors

N/A

References

1. Federal Highway Administration, *Highway Statistics 1988*, Table MF-21
2. United States General Accounting Office, *Highway Funding: Federal Distribution Formulas Should Be Changed*, (Report to the Honorable Lawton Chiles, U.S. Senate, March 1986)

Appendix

Glossary of Terms

Accuracy: Correctness; freedom from mistake or error. Exactness; conformity to truth or to a standard or model. Degree of conformity of a measure to a standard or a true value. The extent to which an operational definition measures the aspect referred to in the nominal definition.

Appropriateness: Suitability. Compatibility. Adapted to an end or design. Suitable by nature or by art. Suitable for or to. Harmonizing with. The quality or state of being especially suitable, compatible, or fitting. An *appropriate* population estimator must be unbiased, consistent, efficient, and sufficient. An unbiased estimator is one for which the expected value of the statistic is equal to the parameter it estimates. A consistent estimator is one which approaches the population parameter as the sample size increases toward total enumeration of the population. An efficient estimator is one with minimum variance.

Currency: The quality or state of occurring or existing at the present time. The quality or state of being most recent. The quality or state of being generally accepted, used, practiced, or prevalent at the moment.

Direct: Marked by the absence of an intervening agency, instrumentality, or influence. Characterized by close logical, causal, or consequential relationship.

Effective: Producing or capable of producing a decided, decisive, or desired effect or result. The actual production of or power to produce an effect.

Efficient: Effective operation as measured by a comparison of production with cost (as energy, time, or money). Producing or capable of producing a decided, decisive, or desired effect or result in such a way as to avoid loss or waste of energy in effecting, producing, or functioning.

Extent: The point, degree, or limit to which something extends. The amount of space or surface that

something occupies or the distance over which it extends.

Highway Performance Monitoring System: A highway data collection system which comprises a combination of sample data on performance and physical characteristics of facilities functionally classified as arterials and collectors, and system-type data for all public roads and street facilities within each state. States submit data annually. When states are unable to report complete data, they provide aggregate area-wide totals.

Manipulation: The act of controlling or changing by artful or unfair means to serve one's own purpose or advantage.

Nature: The inherent character or basic constitution of a person or thing. A kind or class usually distinguished by fundamental or essential characteristics. In the context of this study, the factors considered are classified according to their nature as a measure of the size or extent of the roadway network, the use of that network, bridge or highway system needs, or the estimated cost of the proposed work.

Reliability: The extent to which a repetition of an experiment, test, or measuring procedure yields the same result.

Sensitivity: Readily affected or changed by various agents. Highly responsive or susceptible. Readily fluctuating. (In this study, at least one aspect of the sensitivity of factor is measured by the *variance* of that factor among the states over time. Variance of more than 2 standard deviations above or below the mean is considered worth special comment.)

Surrogate: A person or thing (for example, a measure or factor) which acts in place of another; a substitute or proxy (for example, a related, more readily available, but indirect measure or factor used when a direct measure or factor is not readily available).

Timeliness: The quality of coming early or at the right time. Appropriate or adapted to the times or the occasion.

Translated: Expressed in more comprehensible terms; explained; interpreted.

Uniformity: Consistency, both across the states and across time. The quality or state of having always the same from, manner, or degree; the quality or state of not varying or being invariable. Of the same form with others; conforming to one rule or mode.

Validity: Truth or usefulness. Evidence that an operational measure measures what it purports to measure. The quality or state of being well-grounded or justifiable; being at once relevant and meaningful. The quality or state of being logically correct. Appropriateness to the end in view. Correspondence between the data being collected or interpreted and the aspect of reality that is actually being measured. For a data collection process, one which obtains data that is representative of reality. For data interpretation, procedures and tools for organizing and interpreting data collected that produce relevant and meaningful information.

Less Appropriate Factors

Highways—State Population

Nature

Measure of present and future demand or system need.

Type of Measure: Direct or Surrogate

Surrogate measure.

Accuracy And By Whom Verified

The Decennial Census of Population and Housing includes a 100 percent count of all persons to provide precise data needed for congressional apportionment, legislative redistricting, etc. Units of analysis may be as small as a city block.

The Census Bureau's intercensal estimates of population size does not separate urban and rural

population data. An estimate of urban and rural population that is more accurate than decennial figures could be prepared, however, by calculating the percentage share of each state's urban and rural population from the decennial census, and then multiplying it by the most recent state annual estimate of population.

Validity

Relationship of Highway Extent and Use: Indirect and inexact relationship. Population figures from the decennial census would not recognize intercensal changes in population.

Relationship to Future Highway Needs: Indirect and inexact relationship. Decennial population figures would be too infrequent to be useful. Intercensal estimates might provide trend information.

Timeliness or Currency

A Census of Population and Housing is taken every 10 years. The 21st decennial census was conducted April 1, 1990. From the decennial census, the United States Bureau of the Census prepares population census reports.

The Census Bureau also provides intercensal estimates of population size. The population estimates are derived from a statistical program which updates decennial population figures, as well as from special censuses.

Sensitivity

N/A

Uniformity

The process through which the decennial census is taken is relatively uniform throughout the nation.

Intercensal estimates of population are the results of processes which are probably less uniform than those through which the decennial census is compiled. However, they are probably more accurate than stale decennial data.

By Whom Collected

United States Bureau of the Census.

How Collected

Complete or 100 percent count.

How Raw Data Is Translated

N/A

Susceptibility to Manipulation

N/A

Effectiveness as Incentive to Effective and Efficient System Management

N/A

Appropriateness of Use in Combination with Other Factors

N/A

References

1. Bureau of the Census, U.S. Department of Commerce, *Statistical Abstract of the United States 1989*, Table 331.
2. United States General Accounting Office, *Highway Funding: Federal Distribution Formulas Should Be Changed*, (Report to the Honorable Lawton Chiles, U.S. Senate, March ,1986)
3. United States General Accounting Office, *Federal Formula Programs: Outdated Population Data Used to Allocate Most Funds*, (Report to the Honorable Connie Mack, U.S. Senate, September, 1990)

Highways—State Land Area

Nature

Type of Measure

Uniformity

Accuracy

Remains virtually constant, though state land area can change slightly as border disputes are settled or as bodies of water that serve as state boundaries shift.

Validity and By Whom Validated

N/A

Timeliness or Currency

Updated at 10-year intervals.

Originally included as a factor in 1916 to balance population and reflect future highway needs.

By Whom Collected

The Bureau of the Census develops land area data as part of the decennial census.

How Collected

N/A

How Raw Data Is Translated

N/A

Sensitivity

Remains virtually constant, though state land area can change slightly as border disputes are settled or as bodies of water that serve as state boundaries shift.

Relationship to Highway Extent and Use

Not closely related to extent or use of today's highways.

Gives larger, more sparsely populated states a large share of apportionments than would result from other factors.

Relationship to Future Highway Needs

Does not truly reflect future highway mileage considerations in undeveloped regions. With few exceptions, the country's major roads, including those in formerly underdeveloped regions, were built some time ago. Today, almost all construction work involves either reconstruction of existing highways or new highway construction parallel to old routes.

Susceptibility to Manipulation

N/A

Effectiveness as Incentive

N/A

References

1. Federal Highway Administration, *Highway Statistics 1988*
2. United States General Accounting Office, *Highway Funding: Federal Distribution Formulas Should Be Changed*, (Report to the Honorable Lawton Chiles, U.S. Senate, March, 1986)

Highways—Postal Road Mileage

Nature

Measures total mileage traveled by postal service or contract vehicles for rural and intercity mail delivery during the calendar year.

Type of Measure

Direct

Uniformity

N/A

Accuracy

N/A

Validity and By Whom Validated

Postmaster General annually certifies each state's mileage of rural delivery and intercity mail routes to the Secretary of Transportation (23 USC 104)

Timeliness or Currency

Originally included as a factor in 1916 because federal involvement in highways was justified based on power to establish post offices and post roads. Postal system no longer used as basis for justification of highways since 1919.

By Whom Collected

Postal service. Collected solely to comply with federal highway legislation.

How Collected

Postmaster certifies to FHWA each state's mileage of rural delivery and intercity mail routes.

How Raw Data is Translated

Statute requiring data does not specify how postal mileage is to be computed for certification by the Postmaster General. The choice of methodology is up to the Postal Service. The Postal Service certifies postal mileage as vehicle miles of travel by vehicles in postal service. For example, if a postal vehicle made one round trip each day of the year over a 100-mile stretch of road, the Postal Service would report 73,000 vehicle miles of travel (100 x 2 x 365).

Sensitivity

N/A

Relationship to Highway Extent and Use

Mileage is tabulated without distinguishing the type of road traversed by the postal vehicle. Includes vehicle mileage on and off the federal-aid system, and on and off the system under state jurisdiction. Most postal vehicle travel takes place off the federal-aid system on local rural roads.

Postal vehicle travel accounts for less than 0.1 percent of all travel.

Relationship to Future Highway Needs

N/A

Susceptibility to Manipulation

N/A

Effectiveness as Incentive

N/A

References

1. Federal Highway Administration, *Highway Statistics 1988*
2. United States General Accounting Office, *Highway Funding: Federal Distribution Formulas Should Be Changed*, (Report to the Honorable Lawton Chiles, U.S. Senate, March 1986)

Bridges—Relative Share of Cost to Replace or Rehabilitate**Nature**

Measure of relative need, based on finding of deficiency and cost to repair and replace

Type of Measure

Direct

Uniformity

State bridge data on which the National Bridge Inventory is based is inconsistent. FHWA guidance and oversight of state activities are inadequate to assure consistent data reporting by all states.

Accuracy

FHWA's annual Highway Bridge Replacement and Rehabilitation Program Report to Congress does not accurately identify bridge improvement needs. The National Bridge Inventory does not distinguish bridge deficiencies based on levels of improvement needed and their respective costs. It also is based on inaccurate, incomplete, and inconsistent state bridge data.

FHWA believes new bridge management program will improve type and quality of data collected.

Validity and By Whom Validated

The National Bridge Inventory contains state bridge data which are not adequately verified by FHWA; and contains a national cost-to-improve estimate that is inaccurate because it includes non-deficient bridges, bridges that states do not intend to replace or rehabilitate, and bridges that can be fixed without costly replacement or rehabilitation.

FHWA believes new bridge management program will improve type and quality of data collected.

Timeliness or Currency

Bridge inspections required at regular intervals not to exceed 2 years.

Unit replacement and rehabilitation cost data required annually.

By Whom Collected

Each state prepares and maintains an inventory of all bridges on public roads. The inventory contains the square footage of each bridge. States provide FHWA with copy of inventory.

Based on state inventory data, FHWA classifies all highway bridges as to serviceability, safety, and essentiality for public use.

FHWA identifies eligible bridges needing either replacement or rehabilitation.

States supply data concerning the cost to construct or rehabilitate each eligible bridge.

How Collected

Each bridge on a public road must be inspected at regular intervals not to exceed 2 years.

States compute a weighted average rehabilitation and replacement cost per square foot for each of the four bridge categories.

How Raw Data is Translated

Using the states' bridge inventory data, FHWA identifies eligible bridges using FHWA-AASHTO sufficiency rating formula. A bridge with no deficiencies would have a rating of 100. Of the 100 available points, 55 pertain to a bridge's structural adequacy and safety; 30 pertain to serviceability and functional obsolescence; and 15 pertain to essentiality for public use. To be eligible for rehabilitation, a bridge must have a sufficiency rating of 80 or less. To be eligible for replacement, a bridge must have a sufficiency rating of less than 50.

FHWA categorizes eligible bridges by 1) needing either replacement or rehabilitation, and 2) either on or off the federal-aid system.

Using state-supplied data about the actual construction cost of prior bridge projects in that state, FHWA develops a state-by-state unit construction cost for each of the four bridge categories.

FHWA applies the state unit construction cost to the footage of deficient bridges in each of the four categories.

FHWA sums the total costs for each category in each state to determine that state's bridge replacement and rehabilitation needs, expressed in dollars.

FHWA determines each state's apportionment factor, which is the ratio of each state's total bridge replacement and rehabilitation needs to the national need.

FHWA adjusts the apportionment factors for each state. Each state with an apportionment factor of less than 0.25 percent has its factor increased to 0.25 percent. Each state with an apportionment factor of more than 10 percent has its factor decreased to 10 percent. The remaining states' apportionment factors are recomputed to account for the adjustment of minimum and maximum states and have the total of all apportionment factors total 100 percent.

FHWA determines each state's apportionment by applying that state's adjusted apportionment factor to the total funds available for apportionment.

Sensitivity

The cost factor is intended to compensate for the higher bridge costs in some states. However, a variation in unit costs greater than 400 percent exists among the states. Some contiguous states also have wide unit cost variations, while others do not.

Relationship to Highway Extent and Use

Deficiency based, using need and cost as criteria rather than extent and use.

Level of use is not a dominant factor in the bridge sufficiency formula on which eligibility is determined. The only sufficiency rating factor related to a bridge's traffic volume capacity is its width. Insufficient width can represent no more than 19 points of the total bridge sufficiency rating.

A lightly traveled bridge has the same priority for funds as a heavily traveled one.

Relationship to Future Highway Needs

FHWA's estimate of the total cost of replacing or rehabilitating all bridges classified as deficient is based on state estimates of the cost to improve deficient bridges. Because those state estimates are inconsistently developed, FHWA's estimate of cost to improve is unreliable.

Susceptibility to Manipulation

One state arbitrarily lowered the substructure ratings for its timber bridges without reinspecting them, and recorded the lower ratings in the National Bridge Inventory. This lowered substructure rating, had it not been detected, would have decreased the sufficiency rating for those bridges, increasing the number of deficient and eligible bridges in that state. The increase in total square footage of eligible bridges in that state would have increased the state's apportionment.

Another state developed inspection guidelines that reduced the appraisal ratings for all locally owned bridges. It also established a policy which improved a bridge's rating only if major work had been done on it, disregarding any other type of work that might also have improved the bridge's rating. The result was to give the state an inappropriately high number of deficient bridges.

Another state, in computing the cost per square foot for federal-aid bridge replacement, included unauthorized costs in the computation. That error increased the reported unit cost to improve its deficient bridges, increasing its apportionment.

FHWA's total cost estimate for bridge replacement and rehabilitation includes deficient bridges which can be improved with actions short of total replacement or rehabilitation. FHWA's criteria for deficient bridges includes bridges that are in marginal condition, and bridges that the state has determined are no longer needed.

Effectiveness as Incentive

N/A

References

1. United States General Accounting Office, *Highway Funding: Federal Distribution Formulas Should Be Changed*, (Report to the Honorable Lawton Chiles, U.S. Senate, March 1986)
2. United States General Accounting Office, *Bridge Condition Assessment: Inaccurate Data May Cause Inequities in the Apportionment of Federal-Aid Funding*, (Report to Congressional Requesters, May 1988)
3. Report of the Secretary of Transportation to the United States Congress, *The Status of the Nation's Highways and Bridges: Conditions and Performance and Highway Bridge Replacement and Rehabilitation Program 1989* (June 1989)

Bridges—Number of Deficient or Obsolete Bridges

Nature

Measure of need, based on deficiency.

Type of Measure

Direct

Uniformity

State bridge data on which the National Bridge Inventory is based is inconsistent. FHWA guidance and oversight of state activities are inadequate to assure consistent data reporting by all states.

Accuracy

FHWA's annual Highway Bridge Replacement and Rehabilitation Program Report to Congress does not accurately identify bridge improvement needs. The National Bridge Inventory does not distinguish bridge deficiencies based on levels of improvement needed and their respective costs. It also is based on inaccurate, incomplete, and inconsistent state bridge data.

FHWA believes new bridge management program will improve type and quality of data collected.

Validity and By Whom Validated

Bridge condition ratings may not reliably indicated structural adequacy. The ratings reflect the bridge inspector's judgement about the degree of deterioration in a bridge member. However, the rating may not reflect the adequacy of the bridge to serve traffic with the specific member in that condition.

The National Bridge Inventory contains state bridge data which are not adequately verified by FHWA; and contains a national cost-to-improve estimate that is inaccurate because it includes non-deficient bridges, bridges that states do not intend to replace or rehabilitate, and bridges that can be fixed without costly replacement or rehabilitation.

FHWA believes new bridge management program will improve type and quality of data collected.

Timeliness or Currency

Bridge inspections required at regular intervals not to exceed 2 years.

By Whom Collected

Each state prepares and maintains an inventory of all bridges on public roads.

FHWA and the states inventory all highway bridges and classify them as to serviceability, safety, and essentiality for public use.

FHWA identifies eligible bridges needing either replacement or rehabilitation.

States supply data concerning the cost to construct or rehabilitate each eligible bridge.

How Collected

Each bridge on a public road must be inspected at regular intervals not to exceed 2 years.

How Raw Data is Translated

Using the states' bridge inventory data, FHWA identifies eligible bridges using FHWA-AASHTO sufficiency rating formula. A bridge with no deficiencies would have a rating of 100. Of the 100 available points, 55 pertain to a bridge's structural adequacy and safety; 30 pertain to serviceability and functional obsolescence; and 15 pertain to essentiality for public use. To be eligible for rehabilitation, a bridge must have a sufficiency rating of 80 or less. To be eligible for replacement, a bridge must have a sufficiency rating of less than 50.

FHWA categorizes eligible bridges by 1) needing either replacement or rehabilitation, and 2) either on or off the federal-aid system.

Sensitivity

N/A

Relationship to Highway Extent and Use

Deficiency based, using need as criteria rather than extent and use.

Relationship to Future Highway Needs

Bridge condition ratings may not reliably indicate structural adequacy. The ratings reflect the bridge inspector's judgement about the degree of deterioration in a bridge member. However, the rating may not reflect the adequacy of the bridge to serve traffic with the specific member in that condition.

Susceptibility to Manipulation

One state arbitrarily lowered the substructure ratings for its timber bridges without reinspecting them, and recorded the lower ratings in the National Bridge Inventory. This lowered substructure rating, had it not been detected, would have decreased the sufficiency rating for those bridges, increasing the number of deficient and eligible bridges in that state. The increase in total square footage of eligible bridges in that state would have increased the state's apportionment.

Another state developed inspection guidelines that reduced the appraisal ratings for all locally owned bridges. It also established a policy which improved a bridge's rating only if major work had been done on it, disregarding any other type of work that might also have improved the bridge's rating. The result was to give the state an inappropriately high number of deficient bridges.

Effectiveness as Incentive

N/A

References

1. United States General Accounting Office, *Highway Funding: Federal Distribution Formulas Should Be Changed*, (Report to the Honorable Lawton Chiles, U.S. Senate, March 1986)
2. United States General Accounting Office, *Bridge Condition Assessment: Inaccurate Data May Cause Inequities in the Apportionment of Federal-Aid Funding*, (Report to Congressional Requesters, May 1988)
3. Report of the Secretary of Transportation to the United States Congress, *The Status of the Nation's Highways and Bridges: Conditions and Performance and Highway Bridge Replacement and Rehabilitation Program 1989* (June 1989)

Bridges—Level of Service

Nature

Measure of adequacy and need of bridges within functional classification by comparison to minimum acceptance criteria.

Type of Measure

Current proposal would measure load capacity, clear deck width, vertical over-clearance, and under-clearance.

Indirect

Uniformity

N/A

Accuracy

N/A

Validity and By Whom Validated

N/A

Timeliness or Currency

N/A

By Whom Collected

N/A

How Collected

N/A

How Raw Data is Translated

N/A

Sensitivity

N/A

Relationship to Highway Extent and Use

N/A

Relationship to Future Highway Needs

Load capacity would indicate the bridge's structural adequacy.

Clear deck width would indicate the bridge's traffic capacity.

Vertical clearance would insure accommodation of legal-height vehicles.

Susceptibility to Manipulation

N/A

Effectiveness as Incentive

N/A

References

1. United States General Accounting Office, *Highway Funding: Federal Distribution Formulas Should Be Changed*, (Report to the Honorable Lawton Chiles, U.S. Senate, March 1986)
2. Report of the Secretary of Transportation to the United States Congress, *The Status of the Nation's Highways and Bridges: Conditions and Performance and Highway Bridge Replacement and Rehabilitation Program 1989* (June 1989)
3. FHWA Memorandum: "Level of Service Criteria for Apportionment," from Stanley Gordon, Chief, Bridge Division, Office of Engineering to Regional Federal Highway Administrators and Federal Lands Highway Program Administrators, August 6, 1990.

ALTERNATE FINANCIAL FORMULAS FOR ALLOCATING FEDERAL HIGHWAY FUNDS

Foreword

At its September 6th meeting in Minneapolis, and again at its November 7th meeting in Phoenix, the Policy Review Committee, in execution of a directive adopted by the full AASHTO Policy Committee on July 24th, revisited "the subject of apportionment factors with the goal of establishing as much common ground as possible for guidance during reauthorization activity."

The purpose of this PRC report is to set forth a number of possible formulas that might be considered for allocating federal funds for the proposed Highway System of National Significance. In combination with the companion PRC report on Proposed Formula Factors, the AASHTO member States—individually or in some association—should be better equipped to understand the ramifications of the various allocation formula systems.

This report focuses only on possible formulas for the Categorical Program that has been proposed by AASHTO to support an HSNS. The AASHTO report *New Transportation Concepts for a New Century* proposes that federal funds for the Flexible Program should be distributed on a pro rata share basis of Federal Highway Trust Fund collections attributable to each State. Thus, with the exception of the gasahol issue cited later in this report, the PRC did not revisit the Flexible Program allocation methods.

Following several introductory pages on the current AASHTO recommendations on federal highway aid allocation formulas, prior allocation formula

activities, and remaining issues and concerns, the main body of this report provides state-by-state details of federal funding for a number of possible federal allocation formulas. The possible formulas include three advanced by specific states (California, Maine, and the Dakotas), two identified by FHWA, a Crescent Coalition formula, and four identified as Chandler A through D. The Chandler formulas were first discussed at the November 7th Phoenix meeting.

All the formulas in this report are based upon a prospective \$14.5 billion annual federal highway program, which is somewhat less than the up to \$16.2 billion that may be obligated in fiscal 1991. While the current authorizations are much less than new obligation limits, one would expect that the new federal program will enjoy higher authorization levels.

This report was prepared by the Wisconsin Department of Transportation.

Throughout the course of a two and a half year effort to formulate AASHTO recommendations for the post-Interstate surface transportation program, the AASHTO Policy Committee cumulatively adopted provisions that add up to a comparatively complete set of financing recommendations. As the result of the final AASHTO Policy Committee actions, the report, *New Transportation Concepts for a New Century*, identifies the full range of AASHTO financing recommendations summarized on the following pages.

What AASHTO Has Recommended

1. In its recommendations on the direction of the future Federal Surface Transportation Program and for a National Transportation Policy, AASHTO proposes a two faceted federal highway program:
 - a. A highway System Of National Significance (SONS) to serve the principal interstate commerce and mobility goals of the nation. Composed of existing Interstates and some principal arterial highways, SONS is intended to be a state designated, federally approved, national system that is expected to ultimately result in a 150,000 to 180,000 highway system.
 - b. A Flexible Highway Program (FLEX)—aimed at providing state and local governments with a flexible capacity to meet their distinctive highway needs—focused on urban mobility, suburban congestion, rural access and modal interlinks.
2. AASHTO recommends that the federal highway program be increased from its current level to near \$18 billion in fiscal 1992, and then be gradually further increased to \$26 billion by fiscal 1995.
3. After funding for a modest discretionary bridge program, emergency relief, federal land, roads and other programs, AASHTO recommends that the federal funds be nationally distributed half to the SONS program and half to the FLEX program. Within individual states, of course, the amounts will likely differ from the national 50-50 split. For flexibility, AASHTO also recommends that up to 20 percent of a total state allocation may be shifted either way between the SONS and FLEX programs.
4. Rather than using factors directly related to the highway System of National Significance, AASHTO has recommended that the SONS allocation formula use total statewide urban and rural vehicle miles of travel, total statewide urban and rural lane miles, "and other appropriate factors" for the state-by-state distribution of federal funds. AASHTO, however, did not indicate what the "other appropriate factors" should be, nor what should be the weighting among the five (at least) formula factors.
5. To ensure that each state receives a sufficient share of the national SONS funds, AASHTO further recommends that the existing one-half percent minimum and the existing 85 percent minimum allocation provision be retained for the SONS federal program.
6. For the FLEX program, AASHTO recommends that a donor/donee relationship be avoided. Rather, the FLEX funds be wholly allocated to each state in proportion to the highway user contributions to Federal Highway Trust Fund that is attributable to each state.
7. AASHTO also recommends that funding be set aside for emergency relief, federal lands highways, and for a discretionary bridge program (not more than 2 percent of the total federal program). Presumably, planning and research and safety programs would be financed within the SONS and FLEX programs.
8. By the end of 1991, states will carry about \$11 billion of unobligated apportionment balances that they have been unable to use because of annual obligation limits. AASHTO recommends that states be permitted to fully use their carryover balances. In addition, because all approved Interstate system highways and Interstate substitution projects will not be completely funded by fiscal 1991,

AASHTO urges the prompt funding and completion of these projects. These provisions may consume some resources early in the 1990's, postponing the full implementation of the long-range AASHTO recommendations.

9. The AASHTO recommendations also show concern that, in the shift to a new program structure, states do not experience a reduction in basic federal funding. A hold harmless would ensure each state that it would receive no less total federal highway funding in the new program than in fiscal 1991, as if all states had completed their Interstate highway systems. Hold-harmless amounts will include the state's fiscal 1991 dollar amount of: interstate completion (adjusted to one-half percent of total national allocations), Interstate 4R, Primary, Secondary, Bridges, Metro Planning, Hazard Elimination, Rail-Highway Crossings, and Minimum Allocation. Interstate completion amounts above one-half percent, Interstate Substitution amounts, and any discretionary or demonstration project funding would not be included.
10. Finally, so that all states, including those on hold-harmless, will enjoy some share of federal program increases, AASHTO recommends a percentage growth in hold harmless allocations at an "equitable percentage growth rate" in relation to federal highway funding growth. AASHTO, however, did not define what should be the "equitable percentage growth rate."

What Still is Needed For a Complete AASHTO Financing System:

Within the AASHTO federal highway financing framework, then, there are only three remaining questions to answer in order to develop complete state-by-state estimates of the federal funds that

they might expect in the new federal program. These three question areas are:

1. What should be the "other appropriate" factor(s), in addition to total statewide urban and rural vehicle miles of travel and lane miles, to be used in the SONS allocation formula?
2. What should be the relative weighting among the SONS formula factors?
3. What should be the "equitable percentage growth rate" related to federal funding growth for the hold harmless guarantee?

Prior Allocation Formula Activities

The former Task Force on Highway Finance and Funding Allocation, a creature of the PRC, was established in March, 1989. Members from Delaware, Maryland, New York, Georgia, Florida, North Carolina, Illinois, Indiana, Kansas, North Dakota, Texas, and California and Wisconsin constituted the task force.

Many of the financial issues that were considered by the task force, and for which recommendations were made, were later adopted by the PRC and eventually came to be AASHTO policy recommendations. These included the size of the federal highway program, the split between the categorical and flexible highway programs, the 20 percent transfer provision, a provision to accommodate the unobligated apportionment balances, and some of the framework for an allocation formula.

With regard to allocation formulas, the task force eventually narrowed the many alternatives that were considered to three basic options. The three, each bolstered by hold harmless, 85 percent MA and half percent minimum were:

- Based upon proportionate one-third statewide urban and rural lane miles, one-third statewide urban and rural VMT, and one-third diesel fuel use.

- Based upon proportionate one-third gasoline/gasahol consumption, one-third diesel fuel consumption, one-ninth statewide rural lane miles, and two-ninths statewide urban lane miles.
- Based upon proportionate 25 percent population, 18 percent gasoline/gasahol use, 18 percent diesel fuel use, 14 percent statewide rural lane miles, and 25 percent statewide urban lane miles.

At its September 8th meeting, the PRC considered the three alternative formulas, and selected the first formula to recommend to the Transportation 2020 Task Force.

The Transportation 2020 Task Force met a few weeks later, and while that body endorsed the specific factors, it did not recommend any specific weighting among the factors, and it stated that when feasible the diesel fuel factor should be replaced by a more direct measurement of commercial over-the-road heavy truck travel.

The full AASHTO Policy Committee, at its 1989 Atlanta meeting, made several further changes. The ultimate AASHTO policy recommendations specified that the allocation formula should consist of statewide urban and rural lane miles, statewide urban and rural VMT, "and other appropriate factors." Moreover, it provided that the hold harmless guarantee should be increased at an "equitable percentage growth rate" in relation to federal program growth, and it provided for formula decoupling, "rather than using factors directly tied to the highway system of national significance."

Unresolved Issues and Concerns

In the course of the PRC effort, several significant issues and concerns were raised by the members, but for which the PRC did not formulate specific analyses or recommendations. These unresolved issues and concerns include:

1. In July the AASHTO Policy Committee referred to the PRC the question raised by the Mississippi Valley Conference concerning the effect of gasahol and alternate fuels on the allocation of Flexible Program funds. The PRC did consider the issue, but did not arrive at a definitive recommendation. Here is a synopsis of the two expressed viewpoints:

- a. A continued partial gasahol fuel tax exemption impacts heavily on the principal gasahol producing and consuming states, and would provide them with inadequate Flexible Program funding. With the advent of mandated alternate fuels in air quality nonattainment areas, the impact will spread across the nation. It is said to be unfair to the highway users in these states to base funding on actual collections, rather than tax collections as if gasahol were fully taxed.
- b. An opposing view is that the purpose of the Flexible Program is to flexibly and proportionally return federally collected highway fees to the states to assist their state and local programs. Changing the Flexible Program allocation methods would disturb equity. States who believe they are penalized by extensive gasahol use should work with their Congressional delegations to repeal the gasahol tax exemption.

2. The AASHTO *New Transportation Concepts* report proposes that, except for a high cost bridge discretionary program, all bridge replacement and repair would be funded from the two basic programs—the Categorical and Flexible Programs. Since then, the FHWA has proposed an apportioned bridge program, and it is commonly stated that Congress is very likely to wish to continue a specific bridge program. Thus, AASHTO may wish to ask:

- a. Whether the AASHTO program should consider a separate apportioned bridge replacement and rehabilitation program.
 - b. If so, then what should be the allocation methods to the states. The companion PRC report on proposed formula factors indicates that some of the current bridge formula factors (the bridge cost share specifically) is of lower priority than other possible factors. FHWA apparently will propose a new formula method that is based upon "level of service", but the state-by-state funding results of such an allocation method are unknown.
3. Finally, all the state-by-state funding estimates in this report were prepared in advance of the Congressional decision to enact a five cents per gallon tax increase on all motor fuels. In addition, Congress enacted a long-term continuation of the gasohol partial tax exemption, but at a lower tax rate. Some portion of the tax increase is to be credited to the highway and transit trust funds. To some yet unknown degree, these tax changes will affect the funding distributions, especially the Flexible Program allocations. More definitive information and new estimating techniques will need to be developed in order to include impact of higher federal taxes in the allocation estimates.

SUMMARY COMPARISON -- DOLLAR AMOUNT OF ALTERNATE ALLOCATION FORMULAS

| STATE | Total Estimated FY 1992/1991 | | | | | |
|----------------|---------------------------------|------------|-------------|-------------|-------------|-------------|
| | Apportionments | FHWA #2 | Chandler A | Chandler B | Chandler C | Chandler D |
| ALABAMA | \$217.14 | \$286.48 | \$294.24 | \$292.73 | \$298.62 | \$297.11 |
| ALASKA | \$150.03 | \$175.99 | \$153.34 | \$153.34 | \$153.34 | \$153.34 |
| ARIZONA | \$159.65 | \$219.38 | \$240.14 | \$249.75 | \$221.39 | \$230.12 |
| ARKANSAS | \$150.12 | \$203.15 | \$202.41 | \$200.85 | \$205.82 | \$204.26 |
| CALIFORNIA | \$1,069.12 | \$1,255.97 | \$1,398.84 | \$1,432.98 | \$1,418.24 | \$1,452.37 |
| COLORADO | \$167.45 | \$207.97 | \$179.28 | \$181.23 | \$181.45 | \$183.40 |
| CONNECTICUT | \$329.31 | \$210.78 | \$177.62 | \$164.77 | \$179.85 | \$167.00 |
| DELAWARE | \$50.26 | \$38.44 | \$56.59 | \$56.59 | \$57.39 | \$57.39 |
| D.C. | \$93.45 | \$30.21 | \$54.34 | \$54.34 | \$54.34 | \$54.34 |
| FLORIDA | \$496.28 | \$586.49 | \$656.13 | \$672.86 | \$664.82 | \$681.56 |
| GEORGIA | \$385.88 | \$444.73 | \$485.49 | \$492.80 | \$493.38 | \$500.68 |
| HAWAII | \$100.04 | \$36.40 | \$52.10 | \$52.10 | \$52.84 | \$52.84 |
| IDAHO | \$74.38 | \$96.34 | \$86.35 | \$88.48 | \$72.99 | \$72.99 |
| ILLINOIS | \$327.00 | \$538.56 | \$538.06 | \$541.44 | \$545.69 | \$549.07 |
| INDIANA | \$267.19 | \$335.86 | \$360.28 | \$365.02 | \$366.00 | \$370.74 |
| IOWA | \$148.32 | \$225.36 | \$201.40 | \$196.62 | \$204.36 | \$199.57 |
| KANSAS | \$137.60 | \$240.49 | \$204.31 | \$198.42 | \$207.10 | \$201.22 |
| KENTUCKY | \$166.50 | \$257.24 | \$251.99 | \$250.97 | \$256.34 | \$255.32 |
| LOUISIANA | \$216.14 | \$262.82 | \$263.64 | \$251.11 | \$267.36 | \$254.83 |
| MAINE | \$63.84 | \$87.64 | \$77.34 | \$77.34 | \$78.43 | \$78.43 |
| MARYLAND | \$245.37 | \$219.34 | \$239.21 | \$241.19 | \$242.67 | \$244.65 |
| MASSACHUSETTS | \$927.25 | \$317.03 | \$284.04 | \$273.33 | \$287.48 | \$276.77 |
| MICHIGAN | \$320.64 | \$459.61 | \$453.67 | \$463.49 | \$459.56 | \$469.38 |
| MINNESOTA | \$163.04 | \$278.19 | \$256.61 | \$260.33 | \$260.00 | \$263.72 |
| MISSISSIPPI | \$141.93 | \$195.97 | \$191.95 | \$187.28 | \$194.91 | \$190.24 |
| MISSOURI | \$265.10 | \$397.66 | \$362.41 | \$354.83 | \$367.69 | \$360.11 |
| MONTANA | \$104.28 | \$123.61 | \$107.14 | \$107.14 | \$107.14 | \$107.14 |
| NEBRASKA | \$93.06 | \$157.13 | \$141.55 | \$139.75 | \$124.83 | \$123.27 |
| NEVADA | \$74.34 | \$107.75 | \$100.51 | \$103.80 | \$78.45 | \$80.98 |
| NEW HAMPSHIRE | \$53.67 | \$61.60 | \$63.88 | \$63.88 | \$64.79 | \$64.79 |
| NEW JERSEY | \$366.30 | \$393.78 | \$396.51 | \$390.91 | \$402.04 | \$396.44 |
| NEW MEXICO | \$106.31 | \$140.96 | \$146.59 | \$151.34 | \$119.13 | \$122.93 |
| NEW YORK | \$664.49 | \$713.08 | \$651.49 | \$628.19 | \$659.56 | \$636.26 |
| NORTH CAROLINA | \$322.10 | \$395.65 | \$408.64 | \$413.28 | \$414.84 | \$419.49 |
| NORTH DAKOTA | \$74.82 | \$98.13 | \$81.16 | \$83.30 | \$72.32 | \$72.32 |
| OHIO | \$386.25 | \$542.82 | \$568.60 | \$571.01 | \$577.03 | \$579.44 |
| OKLAHOMA | \$177.64 | \$269.87 | \$257.52 | \$252.97 | \$261.18 | \$256.63 |
| OREGON | \$144.62 | \$207.75 | \$216.24 | \$219.96 | \$199.49 | \$202.87 |
| PENNSYLVANIA | \$506.44 | \$660.18 | \$621.99 | \$601.83 | \$631.21 | \$611.05 |
| RHODE ISLAND | \$113.52 | \$39.28 | \$56.54 | \$56.54 | \$57.35 | \$57.35 |
| SOUTH CAROLINA | \$152.78 | \$194.49 | \$205.15 | \$207.18 | \$208.17 | \$210.20 |
| SOUTH DAKOTA | \$79.46 | \$98.81 | \$85.97 | \$86.10 | \$79.43 | \$79.43 |
| TENNESSEE | \$221.98 | \$332.04 | \$334.46 | \$331.88 | \$339.71 | \$337.13 |
| TEXAS | \$771.94 | \$1,027.64 | \$1,083.74 | \$1,097.47 | \$1,097.86 | \$1,111.58 |
| UTAH | \$91.45 | \$116.99 | \$118.44 | \$121.92 | \$104.48 | \$107.50 |
| VERMONT | \$54.04 | \$44.17 | \$54.65 | \$54.65 | \$54.65 | \$54.65 |
| VIRGINIA | \$266.53 | \$351.86 | \$368.36 | \$370.09 | \$373.96 | \$375.69 |
| WASHINGTON | \$217.42 | \$283.02 | \$272.49 | \$271.58 | \$276.07 | \$275.15 |
| WEST VIRGINIA | \$113.14 | \$153.95 | \$120.05 | \$111.54 | \$121.83 | \$112.25 |
| WISCONSIN | \$209.73 | \$289.48 | \$289.88 | \$292.12 | \$294.00 | \$296.24 |
| WYOMING | \$79.02 | \$87.85 | \$94.60 | \$96.43 | \$80.85 | \$80.85 |
| US TOTAL | \$12,278 | \$14,500 | \$14,567.90 | \$14,579.04 | \$14,592.42 | \$14,593.11 |

SUMMARY COMPARISON -- DOLLAR AMOUNTS

| STATE | Total Estimated FY 1992/1991 | | | | | |
|----------------|---------------------------------|------------|-------------|-------------|-------------|-------------|
| | Apportionments | FHWA #1 | California | Crescent | Dakotas | Maine #2 |
| ALABAMA | \$217.14 | \$294.72 | \$294.96 | \$294.21 | \$263.93 | \$290.47 |
| ALASKA | \$150.03 | \$33.02 | \$153.34 | \$153.34 | \$236.42 | \$153.34 |
| ARIZONA | \$159.65 | \$206.92 | \$228.18 | \$227.55 | \$206.22 | \$210.99 |
| ARKANSAS | \$150.12 | \$207.81 | \$203.31 | \$202.78 | \$173.18 | \$196.61 |
| CALIFORNIA | \$1,069.12 | \$1,254.73 | \$1,440.16 | \$1,435.79 | \$1,251.33 | \$1,363.31 |
| COLORADO | \$167.45 | \$199.64 | \$181.55 | \$181.04 | \$225.50 | \$180.85 |
| CONNECTICUT | \$329.31 | \$214.27 | \$165.58 | \$165.08 | \$245.41 | \$198.94 |
| DELAWARE | \$50.26 | \$39.21 | \$56.89 | \$56.74 | \$64.74 | \$56.09 |
| D.C. | \$93.45 | \$30.47 | \$54.34 | \$54.34 | \$71.91 | \$54.34 |
| FLORIDA | \$496.28 | \$596.59 | \$675.31 | \$673.29 | \$571.40 | \$626.87 |
| GEORGIA | \$385.88 | \$455.25 | \$497.94 | \$496.51 | \$439.42 | \$478.75 |
| HAWAII | \$100.04 | \$35.74 | \$52.34 | \$52.22 | \$65.44 | \$51.60 |
| IDAHO | \$74.38 | \$89.29 | \$79.03 | \$72.99 | \$104.14 | \$72.99 |
| ILLINOIS | \$327.00 | \$556.45 | \$544.60 | \$543.13 | \$525.46 | \$521.57 |
| INDIANA | \$267.19 | \$347.88 | \$368.42 | \$367.46 | \$304.47 | \$349.73 |
| IOWA | \$148.32 | \$237.55 | \$198.16 | \$197.69 | \$217.36 | \$203.07 |
| KANSAS | \$137.60 | \$250.85 | \$199.63 | \$199.14 | \$216.77 | \$208.24 |
| KENTUCKY | \$166.50 | \$263.52 | \$254.19 | \$253.55 | \$244.70 | \$248.50 |
| LOUISIANA | \$216.14 | \$264.53 | \$253.12 | \$252.38 | \$256.11 | \$255.70 |
| MAINE | \$63.84 | \$84.36 | \$77.93 | \$77.48 | \$82.18 | \$79.23 |
| MARYLAND | \$245.37 | \$223.49 | \$242.86 | \$242.12 | \$215.86 | \$235.18 |
| MASSACHUSETTS | \$927.25 | \$323.07 | \$274.13 | \$273.29 | \$320.42 | \$305.14 |
| MICHIGAN | \$320.64 | \$472.74 | \$465.04 | \$463.69 | \$457.13 | \$452.80 |
| MINNESOTA | \$163.04 | \$287.27 | \$261.33 | \$260.64 | \$253.34 | \$257.32 |
| MISSISSIPPI | \$141.93 | \$200.87 | \$189.17 | \$188.66 | \$185.14 | \$189.70 |
| MISSOURI | \$265.10 | \$408.28 | \$357.71 | \$356.69 | \$389.51 | \$372.20 |
| MONTANA | \$104.28 | \$102.88 | \$107.14 | \$107.14 | \$166.26 | \$107.14 |
| NEBRASKA | \$93.06 | \$159.18 | \$129.25 | \$122.03 | \$143.43 | \$128.12 |
| NEVADA | \$74.34 | \$90.09 | \$88.55 | \$80.15 | \$102.40 | \$77.26 |
| NEW HAMPSHIRE | \$53.67 | \$62.73 | \$64.29 | \$64.09 | \$70.97 | \$63.38 |
| NEW JERSEY | \$366.30 | \$400.13 | \$393.41 | \$392.20 | \$351.35 | \$399.40 |
| NEW MEXICO | \$106.31 | \$122.65 | \$134.72 | \$121.81 | \$160.35 | \$115.43 |
| NEW YORK | \$664.49 | \$727.01 | \$630.53 | \$628.60 | \$816.48 | \$687.26 |
| NORTH CAROLINA | \$322.10 | \$404.54 | \$416.85 | \$415.60 | \$370.26 | \$403.39 |
| NORTH DAKOTA | \$74.82 | \$100.39 | \$77.07 | \$72.32 | \$102.36 | \$72.32 |
| OHIO | \$386.25 | \$559.34 | \$575.31 | \$573.70 | \$546.78 | \$551.49 |
| OKLAHOMA | \$177.64 | \$278.34 | \$254.70 | \$254.04 | \$227.93 | \$259.66 |
| OREGON | \$144.62 | \$205.07 | \$201.41 | \$200.88 | \$174.71 | \$191.88 |
| PENNSYLVANIA | \$506.44 | \$676.31 | \$607.30 | \$605.50 | \$648.04 | \$647.06 |
| RHODE ISLAND | \$113.52 | \$40.37 | \$56.85 | \$56.69 | \$63.58 | \$56.04 |
| SOUTH CAROLINA | \$152.78 | \$201.66 | \$208.72 | \$208.15 | \$192.84 | \$201.50 |
| SOUTH DAKOTA | \$79.46 | \$96.40 | \$79.43 | \$79.43 | \$115.81 | \$79.43 |
| TENNESSEE | \$221.98 | \$341.16 | \$335.07 | \$334.19 | \$325.41 | \$330.41 |
| TEXAS | \$771.94 | \$1,030.85 | \$1,101.01 | \$1,097.98 | \$897.64 | \$1,042.74 |
| UTAH | \$91.45 | \$105.46 | \$112.02 | \$106.37 | \$140.69 | \$100.24 |
| VERMONT | \$54.04 | \$45.05 | \$54.65 | \$54.65 | \$71.74 | \$54.65 |
| VIRGINIA | \$266.53 | \$357.44 | \$373.26 | \$372.19 | \$334.21 | \$361.38 |
| WASHINGTON | \$217.42 | \$284.97 | \$272.69 | \$271.93 | \$282.11 | \$274.80 |
| WEST VIRGINIA | \$113.14 | \$155.96 | \$111.54 | \$111.54 | \$171.82 | \$135.14 |
| WISCONSIN | \$209.73 | \$301.09 | \$293.95 | \$293.15 | \$248.33 | \$290.44 |
| WYOMING | \$79.02 | \$72.41 | \$81.66 | \$80.85 | \$119.98 | \$80.85 |
| US TOTAL | \$12,278 | \$14,500 | \$14,530.59 | \$14,446.95 | \$14,432.97 | \$14,324.95 |

SUMMARY COMPARISON -- PERCENT SHARE OF ALTERNATE ALLOCATION FORMULAS

| STATE | % 1989 Contribution | 1991 Appr. Share | Alternate Allocation Formulas | | | | |
|----------------|------------------------|---------------------|-------------------------------|------------|------------|------------|------------|
| | | | FHWA 2 | Chandler A | Chandler B | Chandler C | Chandler D |
| ALABAMA | 1.976% | 1.768% | 1.976% | 2.020% | 2.008% | 2.046% | 2.036% |
| ALASKA | 0.208% | 1.222% | 1.214% | 1.053% | 1.052% | 1.051% | 1.051% |
| ARIZONA | 1.567% | 1.300% | 1.513% | 1.648% | 1.713% | 1.517% | 1.577% |
| ARKANSAS | 1.455% | 1.223% | 1.401% | 1.389% | 1.378% | 1.410% | 1.400% |
| CALIFORNIA | 10.515% | 8.707% | 8.662% | 9.602% | 9.829% | 9.719% | 9.952% |
| COLORADO | 1.217% | 1.364% | 1.434% | 1.231% | 1.243% | 1.243% | 1.257% |
| CONNECTICUT | 1.192% | 2.682% | 1.454% | 1.219% | 1.130% | 1.232% | 1.144% |
| DELAWARE | 0.304% | 0.409% | 0.265% | 0.388% | 0.388% | 0.393% | 0.393% |
| D.C. | 0.149% | 0.761% | 0.208% | 0.373% | 0.373% | 0.372% | 0.372% |
| FLORIDA | 4.802% | 4.042% | 4.045% | 4.504% | 4.615% | 4.556% | 4.670% |
| GEORGIA | 3.693% | 3.143% | 3.067% | 3.333% | 3.380% | 3.381% | 3.431% |
| HAWAII | 0.241% | 0.815% | 0.251% | 0.358% | 0.357% | 0.362% | 0.362% |
| IDAHO | 0.438% | 0.606% | 0.664% | 0.593% | 0.607% | 0.500% | 0.500% |
| ILLINOIS | 3.732% | 2.663% | 3.714% | 3.693% | 3.714% | 3.740% | 3.763% |
| INDIANA | 2.549% | 2.176% | 2.316% | 2.473% | 2.504% | 2.508% | 2.541% |
| IOWA | 1.268% | 1.208% | 1.554% | 1.382% | 1.349% | 1.400% | 1.368% |
| KANSAS | 1.288% | 1.121% | 1.659% | 1.402% | 1.361% | 1.419% | 1.379% |
| KENTUCKY | 1.789% | 1.356% | 1.774% | 1.730% | 1.721% | 1.757% | 1.750% |
| LOUISIANA | 1.853% | 1.760% | 1.813% | 1.810% | 1.722% | 1.832% | 1.746% |
| MAINE | 0.593% | 0.520% | 0.604% | 0.531% | 0.530% | 0.537% | 0.537% |
| MARYLAND | 1.814% | 1.998% | 1.513% | 1.642% | 1.654% | 1.663% | 1.676% |
| MASSACHUSETTS | 1.975% | 7.552% | 2.186% | 1.950% | 1.875% | 1.970% | 1.897% |
| MICHIGAN | 3.239% | 2.611% | 3.170% | 3.114% | 3.179% | 3.149% | 3.216% |
| MINNESOTA | 1.717% | 1.328% | 1.919% | 1.761% | 1.786% | 1.782% | 1.807% |
| MISSISSIPPI | 1.351% | 1.156% | 1.352% | 1.318% | 1.285% | 1.336% | 1.304% |
| MISSOURI | 2.578% | 2.159% | 2.742% | 2.488% | 2.434% | 2.520% | 2.468% |
| MONTANA | 0.478% | 0.849% | 0.852% | 0.735% | 0.735% | 0.734% | 0.734% |
| NEBRASKA | 0.732% | 0.758% | 1.084% | 0.972% | 0.959% | 0.855% | 0.845% |
| NEVADA | 0.548% | 0.605% | 0.743% | 0.690% | 0.712% | 0.538% | 0.555% |
| NEW HAMPSHIRE | 0.407% | 0.437% | 0.425% | 0.439% | 0.438% | 0.444% | 0.444% |
| NEW JERSEY | 2.952% | 2.983% | 2.716% | 2.722% | 2.681% | 2.755% | 2.717% |
| NEW MEXICO | 0.821% | 0.866% | 0.972% | 1.006% | 1.038% | 0.816% | 0.842% |
| NEW YORK | 4.564% | 5.412% | 4.918% | 4.472% | 4.309% | 4.520% | 4.360% |
| NORTH CAROLINA | 3.111% | 2.623% | 2.729% | 2.805% | 2.835% | 2.843% | 2.875% |
| NORTH DAKOTA | 0.356% | 0.609% | 0.677% | 0.557% | 0.571% | 0.496% | 0.496% |
| OHIO | 4.089% | 3.146% | 3.744% | 3.903% | 3.917% | 3.954% | 3.971% |
| OKLAHOMA | 1.707% | 1.447% | 1.861% | 1.768% | 1.735% | 1.790% | 1.759% |
| OREGON | 1.381% | 1.178% | 1.433% | 1.484% | 1.509% | 1.367% | 1.390% |
| PENNSYLVANIA | 4.537% | 4.125% | 4.553% | 4.270% | 4.128% | 4.326% | 4.187% |
| RHODE ISLAND | 0.303% | 0.925% | 0.271% | 0.388% | 0.388% | 0.393% | 0.393% |
| SOUTH CAROLINA | 1.458% | 1.244% | 1.341% | 1.408% | 1.421% | 1.427% | 1.440% |
| SOUTH DAKOTA | 0.378% | 0.647% | 0.681% | 0.590% | 0.591% | 0.544% | 0.544% |
| TENNESSEE | 2.348% | 1.808% | 2.290% | 2.296% | 2.276% | 2.328% | 2.310% |
| TEXAS | 7.403% | 6.287% | 7.087% | 7.439% | 7.528% | 7.523% | 7.617% |
| UTAH | 0.736% | 0.745% | 0.807% | 0.813% | 0.836% | 0.716% | 0.737% |
| VERMONT | 0.252% | 0.440% | 0.305% | 0.375% | 0.375% | 0.375% | 0.374% |
| VIRGINIA | 2.730% | 2.171% | 2.427% | 2.529% | 2.539% | 2.563% | 2.574% |
| WASHINGTON | 1.862% | 1.771% | 1.952% | 1.870% | 1.863% | 1.892% | 1.885% |
| WEST VIRGINIA | 0.848% | 0.921% | 1.062% | 0.824% | 0.765% | 0.835% | 0.769% |
| WISCONSIN | 2.008% | 1.708% | 1.996% | 1.990% | 2.004% | 2.015% | 2.030% |
| WYOMING | 0.489% | 0.644% | 0.606% | 0.649% | 0.661% | 0.554% | 0.554% |
| US TOTAL | 100% | 100% | 100% | 100% | 100% | 100% | 100% |

SUMMARY COMPARISON (continued)

Alternate Allocation Formulas (continued)

| STATE | FHWA #1 | California | Crescent | Dakotas | Maine #2 |
|----------------|---------|------------|----------|---------|----------|
| ALABAMA | 2.033% | 2.030% | 2.037% | 1.829% | 2.028% |
| ALASKA | 0.228% | 1.055% | 1.061% | 1.638% | 1.070% |
| ARIZONA | 1.427% | 1.570% | 1.575% | 1.429% | 1.473% |
| ARKANSAS | 1.433% | 1.399% | 1.404% | 1.200% | 1.373% |
| CALIFORNIA | 8.653% | 9.911% | 9.938% | 8.670% | 9.517% |
| COLORADO | 1.377% | 1.249% | 1.253% | 1.562% | 1.263% |
| CONNECTICUT | 1.478% | 1.139% | 1.143% | 1.700% | 1.389% |
| DELAWARE | 0.270% | 0.392% | 0.393% | 0.449% | 0.392% |
| D.C. | 0.210% | 0.374% | 0.376% | 0.498% | 0.379% |
| FLORIDA | 4.114% | 4.647% | 4.660% | 3.959% | 4.376% |
| GEORGIA | 3.140% | 3.427% | 3.437% | 3.045% | 3.342% |
| HAWAII | 0.247% | 0.360% | 0.361% | 0.453% | 0.360% |
| IDAHO | 0.616% | 0.544% | 0.505% | 0.722% | 0.510% |
| ILLINOIS | 3.838% | 3.748% | 3.759% | 3.641% | 3.641% |
| INDIANA | 2.399% | 2.535% | 2.544% | 2.110% | 2.441% |
| IOWA | 1.638% | 1.364% | 1.368% | 1.506% | 1.418% |
| KANSAS | 1.730% | 1.374% | 1.378% | 1.502% | 1.454% |
| KENTUCKY | 1.817% | 1.749% | 1.755% | 1.695% | 1.735% |
| LOUISIANA | 1.824% | 1.742% | 1.747% | 1.774% | 1.785% |
| MAINE | 0.582% | 0.536% | 0.536% | 0.569% | 0.553% |
| MARYLAND | 1.541% | 1.671% | 1.676% | 1.496% | 1.642% |
| MASSACHUSETTS | 2.228% | 1.887% | 1.892% | 2.220% | 2.130% |
| MICHIGAN | 3.260% | 3.200% | 3.210% | 3.167% | 3.161% |
| MINNESOTA | 1.981% | 1.799% | 1.804% | 1.755% | 1.796% |
| MISSISSIPPI | 1.385% | 1.302% | 1.306% | 1.283% | 1.324% |
| MISSOURI | 2.816% | 2.462% | 2.469% | 2.699% | 2.598% |
| MONTANA | 0.709% | 0.737% | 0.742% | 1.152% | 0.748% |
| NEBRASKA | 1.098% | 0.889% | 0.845% | 0.994% | 0.894% |
| NEVADA | 0.621% | 0.609% | 0.555% | 0.709% | 0.539% |
| NEW HAMPSHIRE | 0.433% | 0.442% | 0.444% | 0.492% | 0.442% |
| NEW JERSEY | 2.760% | 2.707% | 2.715% | 2.434% | 2.788% |
| NEW MEXICO | 0.846% | 0.927% | 0.843% | 1.111% | 0.806% |
| NEW YORK | 5.014% | 4.339% | 4.351% | 5.657% | 4.798% |
| NORTH CAROLINA | 2.790% | 2.869% | 2.877% | 2.565% | 2.816% |
| NORTH DAKOTA | 0.692% | 0.530% | 0.501% | 0.709% | 0.505% |
| OHIO | 3.858% | 3.959% | 3.971% | 3.788% | 3.850% |
| OKLAHOMA | 1.920% | 1.753% | 1.758% | 1.579% | 1.813% |
| OREGON | 1.414% | 1.386% | 1.390% | 1.211% | 1.339% |
| PENNSYLVANIA | 4.664% | 4.179% | 4.191% | 4.490% | 4.517% |
| RHODE ISLAND | 0.278% | 0.391% | 0.392% | 0.440% | 0.391% |
| SOUTH CAROLINA | 1.391% | 1.436% | 1.441% | 1.336% | 1.407% |
| SOUTH DAKOTA | 0.665% | 0.547% | 0.550% | 0.802% | 0.554% |
| TENNESSEE | 2.353% | 2.306% | 2.313% | 2.255% | 2.307% |
| TEXAS | 7.109% | 7.577% | 7.600% | 6.219% | 7.279% |
| UTAH | 0.727% | 0.771% | 0.736% | 0.975% | 0.700% |
| VERMONT | 0.311% | 0.376% | 0.378% | 0.497% | 0.381% |
| VIRGINIA | 2.465% | 2.569% | 2.576% | 2.316% | 2.523% |
| WASHINGTON | 1.965% | 1.877% | 1.882% | 1.955% | 1.918% |
| WEST VIRGINIA | 1.076% | 0.768% | 0.772% | 1.190% | 0.943% |
| WISCONSIN | 2.076% | 2.023% | 2.029% | 1.721% | 2.028% |
| WYOMING | 0.499% | 0.562% | 0.560% | 0.831% | 0.564% |
| US TOTAL | 100% | 100% | 100% | 100% | 100% |

PERCENTAGE AIDS - PERCENTAGE PAYMENTS RATIO

| STATE | 1991 Appr Share / 1989 Payments | FHWA #2 | Chandler A | Chandler B | Chandler C | Chandler D |
|----------------|------------------------------------|---------|------------|------------|------------|------------|
| ALABAMA | 89.51% | 100.00% | 102.23% | 101.63% | 103.57% | 103.05% |
| ALASKA | 586.82% | 582.88% | 505.49% | 505.11% | 504.64% | 504.62% |
| ARIZONA | 82.98% | 96.56% | 105.20% | 109.33% | 96.82% | 100.64% |
| ARKANSAS | 84.01% | 96.27% | 95.47% | 94.67% | 96.92% | 96.18% |
| CALIFORNIA | 82.81% | 82.37% | 91.32% | 93.47% | 92.43% | 94.65% |
| COLORADO | 112.10% | 117.90% | 101.16% | 102.18% | 102.21% | 103.30% |
| CONNECTICUT | 224.93% | 121.91% | 102.26% | 94.79% | 103.36% | 95.98% |
| DELAWARE | 134.64% | 87.19% | 127.76% | 127.67% | 129.36% | 129.36% |
| D.C. | 511.33% | 140.00% | 250.63% | 250.44% | 250.21% | 250.20% |
| FLORIDA | 84.18% | 84.24% | 93.80% | 96.12% | 94.88% | 97.27% |
| GEORGIA | 85.11% | 83.06% | 90.25% | 91.54% | 91.56% | 92.91% |
| HAWAII | 338.39% | 104.26% | 148.52% | 148.41% | 150.38% | 150.37% |
| IDAHO | 138.39% | 151.78% | 135.40% | 138.64% | 114.27% | 114.26% |
| ILLINOIS | 71.37% | 99.53% | 98.98% | 99.52% | 100.21% | 100.83% |
| INDIANA | 85.37% | 90.87% | 97.02% | 98.22% | 98.40% | 99.67% |
| IOWA | 95.26% | 122.57% | 109.02% | 106.35% | 110.44% | 107.85% |
| KANSAS | 86.98% | 128.73% | 108.85% | 105.63% | 110.15% | 107.01% |
| KENTUCKY | 75.81% | 99.17% | 96.70% | 96.23% | 98.20% | 97.81% |
| LOUISIANA | 95.02% | 97.83% | 97.68% | 92.97% | 98.89% | 94.25% |
| MAINE | 87.73% | 101.99% | 89.58% | 89.51% | 90.70% | 90.69% |
| MARYLAND | 110.17% | 83.39% | 90.52% | 91.20% | 91.68% | 92.42% |
| MASSACHUSETTS | 382.39% | 110.71% | 98.73% | 94.93% | 99.75% | 96.03% |
| MICHIGAN | 80.63% | 97.87% | 96.15% | 98.16% | 97.24% | 99.31% |
| MINNESOTA | 77.36% | 111.77% | 102.62% | 104.03% | 103.80% | 105.28% |
| MISSISSIPPI | 85.57% | 100.05% | 97.54% | 95.10% | 98.88% | 96.51% |
| MISSOURI | 83.76% | 106.39% | 96.51% | 94.42% | 97.75% | 95.73% |
| MONTANA | 177.51% | 178.16% | 153.70% | 153.59% | 153.44% | 153.44% |
| NEBRASKA | 103.52% | 148.00% | 132.71% | 130.92% | 116.84% | 115.37% |
| NEVADA | 110.50% | 135.62% | 125.92% | 129.94% | 98.12% | 101.27% |
| NEW HAMPSHIRE | 107.45% | 104.44% | 107.80% | 107.71% | 109.14% | 109.14% |
| NEW JERSEY | 101.04% | 91.98% | 92.19% | 90.81% | 93.32% | 92.01% |
| NEW MEXICO | 105.47% | 118.42% | 122.58% | 126.45% | 99.45% | 102.61% |
| NEW YORK | 118.59% | 107.76% | 97.99% | 94.42% | 99.04% | 95.54% |
| NORTH CAROLINA | 84.31% | 87.70% | 90.15% | 91.11% | 91.37% | 92.39% |
| NORTH DAKOTA | 171.32% | 190.25% | 156.61% | 160.63% | 139.32% | 139.31% |
| OHIO | 76.93% | 91.55% | 95.45% | 95.78% | 96.70% | 97.10% |
| OKLAHOMA | 84.74% | 109.02% | 103.54% | 101.63% | 104.84% | 103.01% |
| OREGON | 85.30% | 103.76% | 107.50% | 109.27% | 99.01% | 100.68% |
| PENNSYLVANIA | 90.90% | 100.34% | 94.10% | 90.98% | 95.33% | 92.28% |
| RHODE ISLAND | 304.72% | 89.28% | 127.92% | 127.82% | 129.52% | 129.51% |
| SOUTH CAROLINA | 85.36% | 92.02% | 96.61% | 97.49% | 97.87% | 98.81% |
| SOUTH DAKOTA | 171.33% | 180.42% | 156.23% | 156.35% | 144.11% | 144.10% |
| TENNESSEE | 76.98% | 97.51% | 97.76% | 96.93% | 99.13% | 98.37% |
| TEXAS | 84.92% | 95.73% | 100.48% | 101.68% | 101.62% | 102.89% |
| UTAH | 101.13% | 109.55% | 110.39% | 113.55% | 97.22% | 100.03% |
| VERMONT | 174.90% | 121.03% | 149.07% | 148.95% | 148.82% | 148.81% |
| VIRGINIA | 79.51% | 88.88% | 92.61% | 92.98% | 93.86% | 94.29% |
| WASHINGTON | 95.12% | 104.85% | 100.48% | 100.06% | 101.63% | 101.28% |
| WEST VIRGINIA | 108.65% | 125.18% | 97.16% | 90.21% | 98.44% | 90.69% |
| WISCONSIN | 85.07% | 99.43% | 99.10% | 99.79% | 100.34% | 101.10% |
| WYOMING | 131.56% | 123.85% | 132.75% | 135.21% | 113.26% | 113.26% |

PERCENTAGE AIDS - PERCENTAGE PAYMENTS RATIO (continued)

| STATE | 1991 Appr Share / 1989 Payments | FHWA #1 | California | Crescent | Dakotas | Maine #2 |
|----------------|------------------------------------|---------|------------|----------|---------|----------|
| ALABAMA | 89.51% | 102.87% | 102.74% | 103.07% | 92.55% | 102.63% |
| ALASKA | 586.82% | 109.35% | 506.79% | 509.73% | 786.68% | 514.07% |
| ARIZONA | 82.98% | 91.07% | 100.22% | 100.52% | 91.19% | 94.00% |
| ARKANSAS | 84.01% | 98.48% | 96.14% | 96.45% | 82.45% | 94.31% |
| CALIFORNIA | 82.81% | 82.29% | 94.25% | 94.51% | 82.45% | 90.51% |
| COLORADO | 112.10% | 113.17% | 102.70% | 103.00% | 128.43% | 103.78% |
| CONNECTICUT | 224.93% | 123.93% | 95.57% | 95.83% | 142.60% | 116.47% |
| DELAWARE | 134.64% | 88.95% | 128.78% | 129.18% | 147.54% | 128.78% |
| D.C. | 511.33% | 141.19% | 251.27% | 252.73% | 334.76% | 254.88% |
| FLORIDA | 84.18% | 85.69% | 96.79% | 97.06% | 82.45% | 91.14% |
| GEORGIA | 85.11% | 85.03% | 92.80% | 93.07% | 82.45% | 90.51% |
| HAWAII | 338.39% | 102.38% | 149.59% | 150.11% | 188.31% | 149.59% |
| IDAHO | 138.39% | 140.67% | 124.24% | 115.42% | 164.83% | 116.40% |
| ILLINOIS | 71.37% | 102.84% | 100.44% | 100.75% | 97.56% | 97.57% |
| INDIANA | 85.37% | 94.12% | 99.47% | 99.78% | 82.76% | 95.78% |
| IOWA | 95.26% | 129.20% | 107.55% | 107.92% | 118.76% | 111.80% |
| KANSAS | 86.98% | 134.27% | 106.63% | 106.98% | 116.56% | 112.82% |
| KENTUCKY | 75.81% | 101.59% | 97.79% | 98.11% | 94.78% | 96.98% |
| LOUISIANA | 95.02% | 98.47% | 94.02% | 94.29% | 95.78% | 96.35% |
| MAINE | 87.73% | 98.18% | 90.50% | 90.50% | 96.08% | 93.33% |
| MARYLAND | 110.17% | 84.97% | 92.14% | 92.39% | 82.45% | 90.51% |
| MASSACHUSETTS | 382.39% | 112.82% | 95.53% | 95.78% | 112.41% | 107.86% |
| MICHIGAN | 80.63% | 100.66% | 98.82% | 99.10% | 97.79% | 97.60% |
| MINNESOTA | 77.36% | 115.42% | 104.78% | 105.11% | 102.26% | 104.65% |
| MISSISSIPPI | 85.57% | 102.55% | 96.38% | 96.67% | 94.96% | 98.03% |
| MISSOURI | 83.76% | 109.23% | 95.50% | 95.78% | 104.70% | 100.80% |
| MONTANA | 177.51% | 148.28% | 154.10% | 154.99% | 240.75% | 156.31% |
| NEBRASKA | 103.52% | 149.93% | 121.48% | 115.36% | 135.73% | 122.15% |
| NEVADA | 110.50% | 113.40% | 111.22% | 101.25% | 129.48% | 98.43% |
| NEW HAMPSHIRE | 107.45% | 106.36% | 108.76% | 109.05% | 120.87% | 108.77% |
| NEW JERSEY | 101.04% | 93.46% | 91.70% | 91.95% | 82.45% | 94.43% |
| NEW MEXICO | 105.47% | 103.04% | 112.94% | 102.71% | 135.34% | 98.16% |
| NEW YORK | 118.59% | 109.87% | 95.09% | 95.34% | 123.96% | 105.13% |
| NORTH CAROLINA | 84.31% | 89.67% | 92.20% | 92.46% | 82.45% | 90.51% |
| NORTH DAKOTA | 171.32% | 194.63% | 149.11% | 140.72% | 199.37% | 141.92% |
| OHIO | 76.93% | 94.34% | 96.83% | 97.11% | 92.65% | 94.15% |
| OKLAHOMA | 84.74% | 112.44% | 102.67% | 103.00% | 92.50% | 106.17% |
| OREGON | 85.30% | 102.43% | 100.39% | 100.70% | 87.67% | 97.01% |
| PENNSYLVANIA | 90.90% | 102.80% | 92.11% | 92.37% | 98.96% | 99.55% |
| RHODE ISLAND | 304.72% | 91.77% | 128.94% | 129.34% | 145.18% | 128.94% |
| SOUTH CAROLINA | 85.36% | 95.41% | 98.54% | 98.84% | 91.66% | 96.50% |
| SOUTH DAKOTA | 171.33% | 176.01% | 144.72% | 145.56% | 212.44% | 146.80% |
| TENNESSEE | 76.98% | 100.19% | 98.19% | 98.50% | 96.00% | 98.21% |
| TEXAS | 84.92% | 96.03% | 102.35% | 102.66% | 84.01% | 98.32% |
| UTAH | 101.13% | 98.75% | 104.68% | 99.97% | 132.36% | 95.02% |
| VERMONT | 174.90% | 123.45% | 149.45% | 150.31% | 197.51% | 151.59% |
| VIRGINIA | 79.51% | 90.29% | 94.09% | 94.36% | 84.82% | 92.40% |
| WASHINGTON | 95.12% | 105.57% | 100.81% | 101.11% | 105.00% | 103.05% |
| WEST VIRGINIA | 108.65% | 126.82% | 90.51% | 91.03% | 140.37% | 111.23% |
| WISCONSIN | 85.07% | 103.42% | 100.75% | 101.06% | 85.69% | 100.98% |
| WYOMING | 131.56% | 102.09% | 114.89% | 114.40% | 169.94% | 115.38% |

Formula Specifications

CHANDLER A

FEDERAL PROGRAM CATEGORIES:

Categorical Program: 50% of Federal Funds
Flexible Program: 50% of Federal Funds

FORMULAS:

Categorical Program: 5.7% Proportional Bridge Deck Area
5.7% " Bridge Cost Share
10.0% " Rural Lane Miles
20.0% " Urban Lane Miles
10.0% " Rural VMT
20.0% " Urban VMT
28.6% " Diesel Fuel Purchases

100.0% of Categorical Program Federal Apportionments

Flexible Program: Proportional Contributions to Highway Trust Fund

Density Factor: Increase Categorical and Flexible Funds By:

| Percent Increase | Persons Per Sq. Mile |
|------------------|----------------------|
| 35% | Fewer than 5 |
| 30% | 5 to 9.9 |
| 25% | 10 to 14.9 |
| 20% | 15 to 19.9 |
| 15% | 20 to 24.9 |
| 10% | 25 to 29.9 |
| 0% | 30 or More |

GUARANTEED FEDERAL FUNDING OF NO LESS THAN:

Half Percent: Half Percent of Categorical Program Apportionments

Minimum Allocation: Percent Categorical Apportionments No Less Than 85% of that State's Percent Contributions.

Hold Harmless: FY 1992 and Subsequent Total Federal Funding No Less Than FY 1991 Dollar Amount (less Interstate Completion above half percent, Interstate Transfer, Discretionary and Demonstration Projects) of Federal Highway Funds.

\$14.5 Billion level

CHANDLER A

ALLOCATION FORMULA

CATEGORICAL PROGRAM DETAIL

| STATE | Bridge Factors | | Lane Miles | | VMT | | Diesel Fuels | Total Allocation | % of Total |
|----------------|-----------------|------------------|------------|------------|----------|------------|--------------|------------------|------------|
| | Total Deck Area | Total Cost Share | Rural | Urban | Rural | Urban | | | |
| ALABAMA | \$10.11 | \$8.66 | \$16.45 | \$31.10 | \$17.93 | \$21.73 | \$48.00 | \$153.96 | 2.20% |
| ALASKA | \$0.74 | \$1.00 | \$2.25 | \$3.13 | \$1.79 | \$2.03 | \$4.32 | \$15.26 | 0.22% |
| ARIZONA | \$3.60 | \$1.00 | \$13.34 | \$23.27 | \$11.69 | \$23.87 | \$30.28 | \$107.06 | 1.53% |
| ARKANSAS | \$7.28 | \$5.01 | \$15.29 | \$13.99 | \$10.48 | \$8.09 | \$38.94 | \$99.09 | 1.42% |
| CALIFORNIA | \$31.99 | \$13.01 | \$20.78 | \$144.32 | \$43.73 | \$220.77 | \$177.65 | \$652.25 | 9.32% |
| COLORADO | \$5.13 | \$4.06 | \$14.66 | \$21.24 | \$9.38 | \$19.36 | \$19.07 | \$92.91 | 1.33% |
| CONNECTICUT | \$4.28 | \$17.81 | \$2.02 | \$19.92 | \$5.61 | \$22.62 | \$20.71 | \$92.96 | 1.33% |
| DELAWARE | \$1.13 | \$1.18 | \$0.87 | \$3.04 | \$2.49 | \$4.06 | \$5.59 | \$18.35 | 0.26% |
| D.C. | \$0.78 | \$3.17 | \$0.00 | \$2.26 | \$0.00 | \$3.95 | \$2.32 | \$12.48 | 0.18% |
| FLORIDA | \$15.20 | \$6.64 | \$12.98 | \$89.36 | \$25.25 | \$87.88 | \$77.90 | \$315.21 | 4.50% |
| GEORGIA | \$10.20 | \$8.18 | \$19.45 | \$38.30 | \$25.11 | \$38.17 | \$83.91 | \$223.32 | 3.19% |
| HAWAII | \$1.16 | \$1.32 | \$0.59 | \$2.86 | \$1.99 | \$5.90 | \$2.29 | \$16.12 | 0.23% |
| IDAHO | \$1.88 | \$1.00 | \$12.89 | \$4.45 | \$4.80 | \$2.93 | \$10.06 | \$38.00 | 0.54% |
| ILLINOIS | \$16.53 | \$11.73 | \$23.23 | \$60.10 | \$21.10 | \$62.40 | \$78.03 | \$273.11 | 3.90% |
| INDIANA | \$9.08 | \$6.80 | \$16.70 | \$32.65 | \$24.41 | \$26.21 | \$63.45 | \$179.30 | 2.56% |
| IOWA | \$9.54 | \$7.30 | \$22.99 | \$16.61 | \$11.99 | \$9.16 | \$33.78 | \$111.37 | 1.59% |
| KANSAS | \$10.46 | \$7.66 | \$27.41 | \$16.24 | \$10.27 | \$10.62 | \$30.16 | \$112.82 | 1.61% |
| KENTUCKY | \$6.58 | \$8.02 | \$13.93 | \$14.23 | \$15.90 | \$15.12 | \$51.22 | \$124.98 | 1.79% |
| LOUISIANA | \$16.84 | \$9.24 | \$10.35 | \$23.35 | \$14.71 | \$20.28 | \$37.33 | \$132.10 | 1.89% |
| MAINE | \$1.50 | \$2.50 | \$4.36 | \$4.31 | \$7.14 | \$3.55 | \$11.62 | \$34.98 | 0.50% |
| MARYLAND | \$5.67 | \$5.17 | \$3.73 | \$23.39 | \$10.93 | \$28.66 | \$32.87 | \$110.42 | 1.58% |
| MASSACHUSETTS | \$5.52 | \$20.72 | \$2.96 | \$37.45 | \$6.71 | \$41.14 | \$29.31 | \$143.82 | 2.05% |
| MICHIGAN | \$8.21 | \$9.16 | \$20.25 | \$52.03 | \$26.34 | \$54.62 | \$53.10 | \$223.71 | 3.20% |
| MINNESOTA | \$7.34 | \$5.00 | \$25.66 | \$26.21 | \$14.66 | \$22.39 | \$33.48 | \$134.74 | 1.92% |
| MISSISSIPPI | \$8.92 | \$5.96 | \$14.49 | \$13.45 | \$12.70 | \$8.35 | \$32.17 | \$96.04 | 1.37% |
| MISSOURI | \$10.81 | \$16.22 | \$23.19 | \$28.94 | \$18.74 | \$27.45 | \$54.04 | \$179.40 | 2.56% |
| MONTANA | \$2.72 | \$2.09 | \$15.36 | \$3.98 | \$5.22 | \$2.37 | \$11.70 | \$43.43 | 0.62% |
| NEBRASKA | \$4.65 | \$4.84 | \$19.29 | \$9.06 | \$7.26 | \$5.71 | \$20.29 | \$71.10 | 1.02% |
| NEVADA | \$1.15 | \$1.00 | \$9.28 | \$6.07 | \$3.33 | \$5.91 | \$11.67 | \$38.41 | 0.55% |
| NEW HAMPSHIRE | \$1.39 | \$2.17 | \$2.75 | \$4.31 | \$5.02 | \$4.23 | \$5.86 | \$25.72 | 0.37% |
| NEW JERSEY | \$8.63 | \$17.70 | \$2.70 | \$41.47 | \$9.28 | \$55.44 | \$51.67 | \$186.88 | 2.67% |
| NEW MEXICO | \$1.95 | \$1.32 | \$11.11 | \$9.05 | \$7.97 | \$6.92 | \$20.67 | \$58.99 | 0.84% |
| NEW YORK | \$18.57 | \$40.12 | \$16.38 | \$71.12 | \$25.82 | \$85.22 | \$70.24 | \$327.47 | 4.68% |
| NORTH CAROLINA | \$8.83 | \$8.25 | \$16.86 | \$34.39 | \$27.24 | \$30.29 | \$61.87 | \$187.73 | 2.68% |
| NORTH DAKOTA | \$1.64 | \$1.48 | \$18.70 | \$3.27 | \$3.62 | \$1.79 | \$9.19 | \$39.67 | 0.57% |
| OHIO | \$16.85 | \$12.56 | \$18.51 | \$58.99 | \$29.99 | \$54.43 | \$86.95 | \$278.27 | 3.98% |
| OKLAHOMA | \$10.26 | \$9.30 | \$22.08 | \$22.98 | \$13.87 | \$18.76 | \$39.06 | \$136.30 | 1.95% |
| OREGON | \$6.00 | \$2.21 | \$18.81 | \$15.99 | \$11.85 | \$13.17 | \$30.52 | \$98.55 | 1.41% |
| PENNSYLVANIA | \$16.18 | \$35.43 | \$19.88 | \$51.64 | \$31.45 | \$51.58 | \$93.69 | \$299.83 | 4.28% |
| RHODE ISLAND | \$0.97 | \$1.00 | \$0.34 | \$8.02 | \$0.77 | \$5.73 | \$4.40 | \$21.24 | 0.30% |
| SOUTH CAROLINA | \$6.38 | \$3.38 | \$12.26 | \$17.67 | \$17.44 | \$13.20 | \$31.33 | \$101.65 | 1.45% |
| SOUTH DAKOTA | \$2.48 | \$1.98 | \$15.89 | \$3.27 | \$4.37 | \$1.78 | \$9.53 | \$39.31 | 0.56% |
| TENNESSEE | \$10.10 | \$10.95 | \$15.28 | \$28.69 | \$18.36 | \$26.36 | \$57.97 | \$167.72 | 2.40% |
| TEXAS | \$36.96 | \$15.77 | \$48.90 | \$157.25 | \$45.99 | \$119.07 | \$134.16 | \$558.10 | 7.97% |
| UTAH | \$2.12 | \$1.00 | \$8.42 | \$10.27 | \$4.34 | \$9.49 | \$15.05 | \$50.70 | 0.72% |
| VERMONT | \$1.18 | \$2.25 | \$2.95 | \$1.74 | \$3.66 | \$1.48 | \$4.59 | \$17.84 | 0.25% |
| VIRGINIA | \$9.30 | \$8.84 | \$11.95 | \$28.47 | \$22.76 | \$35.77 | \$57.40 | \$174.51 | 2.49% |
| WASHINGTON | \$7.90 | \$9.16 | \$14.48 | \$30.68 | \$13.09 | \$30.73 | \$34.27 | \$140.32 | 2.00% |
| WEST VIRGINIA | \$3.96 | \$11.54 | \$7.07 | \$5.45 | \$8.56 | \$4.51 | \$18.74 | \$59.83 | 0.85% |
| WISCONSIN | \$7.74 | \$7.13 | \$21.28 | \$26.47 | \$19.19 | \$23.22 | \$42.28 | \$147.32 | 2.10% |
| WYOMING | \$1.66 | \$1.00 | \$8.64 | \$3.52 | \$3.71 | \$1.54 | \$15.27 | \$35.34 | 0.50% |
| US TOTAL | \$400.00 | \$400.00 | \$700.00 | \$1,400.00 | \$700.00 | \$1,400.00 | \$2,000.00 | \$7,000.00 | 100% |

\$14.5 Billion Level

CHANDLER A

ALLOCATION FORMULA

SUMMARY FUNDING

| STATE | Categorical Program | | | | Flexible Program | Density Factor | Hold Harmless | Total Funding | % of Total Funding |
|----------------|---------------------|----------|--------|------------|------------------|----------------|---------------|---------------|--------------------|
| | Formula | Half % | 85% MA | Total | | | | | |
| ALABAMA | \$153.96 | | | \$153.96 | \$140.28 | | | \$294.24 | 2.020% |
| ALASKA | \$15.26 | \$19.74 | | \$35.00 | \$14.78 | | \$86.13 | \$153.34 | 1.053% |
| ARIZONA | \$107.06 | | | \$107.06 | \$111.25 | \$21.83 | | \$240.14 | 1.648% |
| ARKANSAS | \$99.09 | | | \$99.09 | \$103.33 | | | \$202.41 | 1.389% |
| CALIFORNIA | \$652.25 | | | \$652.25 | \$746.59 | | | \$1,398.84 | 9.602% |
| COLORADO | \$92.91 | | | \$92.91 | \$86.38 | | | \$179.28 | 1.231% |
| CONNECTICUT | \$92.96 | | | \$92.96 | \$84.66 | | | \$177.62 | 1.219% |
| DELAWARE | \$18.35 | \$16.65 | | \$35.00 | \$21.59 | | | \$56.59 | 0.388% |
| D.C. | \$12.48 | \$22.52 | | \$35.00 | \$10.57 | | \$8.78 | \$54.34 | 0.373% |
| FLORIDA | \$315.21 | | | \$315.21 | \$340.92 | | | \$656.13 | 4.504% |
| GEORGIA | \$223.32 | | | \$223.32 | \$262.18 | | | \$485.49 | 3.333% |
| HAWAII | \$16.12 | \$18.88 | | \$35.00 | \$17.10 | | | \$52.10 | 0.358% |
| IDAHO | \$38.00 | | | \$38.00 | \$31.08 | \$17.27 | | \$86.35 | 0.593% |
| ILLINOIS | \$273.11 | | | \$273.11 | \$264.95 | | | \$538.06 | 3.693% |
| INDIANA | \$179.30 | | | \$179.30 | \$180.98 | | | \$360.28 | 2.473% |
| IOWA | \$111.37 | | | \$111.37 | \$90.03 | | | \$201.40 | 1.382% |
| KANSAS | \$112.82 | | | \$112.82 | \$91.48 | | | \$204.31 | 1.402% |
| KENTUCKY | \$124.98 | | | \$124.98 | \$127.01 | | | \$251.99 | 1.730% |
| LOUISIANA | \$132.10 | | | \$132.10 | \$131.54 | | | \$263.64 | 1.810% |
| MAINE | \$34.98 | \$0.02 | \$0.26 | \$35.26 | \$42.08 | | | \$77.34 | 0.531% |
| MARYLAND | \$110.42 | | | \$110.42 | \$128.79 | | | \$239.21 | 1.642% |
| MASSACHUSETTS | \$143.82 | | | \$143.82 | \$140.22 | | | \$284.04 | 1.950% |
| MICHIGAN | \$223.71 | | | \$223.71 | \$229.95 | | | \$453.67 | 3.114% |
| MINNESOTA | \$134.74 | | | \$134.74 | \$121.87 | | | \$256.61 | 1.761% |
| MISSISSIPPI | \$96.04 | | | \$96.04 | \$95.91 | | | \$191.95 | 1.318% |
| MISSOURI | \$179.40 | | | \$179.40 | \$183.02 | | | \$362.41 | 2.488% |
| MONTANA | \$43.43 | | | \$43.43 | \$33.97 | \$23.22 | \$6.52 | \$107.14 | 0.735% |
| NEBRASKA | \$71.10 | | | \$71.10 | \$51.98 | \$18.46 | | \$141.55 | 0.972% |
| NEVADA | \$38.41 | | | \$38.41 | \$38.90 | \$23.20 | | \$100.51 | 0.690% |
| NEW HAMPSHIRE | \$25.72 | \$9.28 | | \$35.00 | \$28.88 | | | \$63.88 | 0.439% |
| NEW JERSEY | \$186.88 | | | \$186.88 | \$209.63 | | | \$396.51 | 2.722% |
| NEW MEXICO | \$58.99 | | | \$58.99 | \$58.28 | \$29.32 | | \$146.59 | 1.006% |
| NEW YORK | \$327.47 | | | \$327.47 | \$324.02 | | | \$651.49 | 4.472% |
| CAROLINA | \$187.73 | | | \$187.73 | \$220.91 | | | \$408.64 | 2.805% |
| DAKOTA | \$39.67 | | | \$39.67 | \$25.26 | \$16.23 | | \$81.16 | 0.557% |
| | \$278.27 | | | \$278.27 | \$290.33 | | | \$568.60 | 3.903% |
| OKLAHOMA | \$136.30 | | | \$136.30 | \$121.21 | | | \$257.52 | 1.768% |
| OREGON | \$98.55 | | | \$98.55 | \$98.03 | \$19.66 | | \$216.24 | 1.484% |
| PENNSYLVANIA | \$299.83 | | | \$299.83 | \$322.15 | | | \$621.99 | 4.270% |
| RHODE ISLAND | \$21.24 | \$13.76 | | \$35.00 | \$21.54 | | | \$56.54 | 0.388% |
| SOUTH CAROLINA | \$101.65 | | | \$101.65 | \$103.50 | | | \$205.15 | 1.408% |
| SOUTH DAKOTA | \$39.31 | | | \$39.31 | \$26.82 | \$19.84 | | \$85.97 | 0.590% |
| TENNESSEE | \$167.72 | | | \$167.72 | \$166.74 | | | \$334.46 | 2.296% |
| TEXAS | \$558.10 | | | \$558.10 | \$525.64 | | | \$1,083.74 | 7.439% |
| UTAH | \$50.70 | | | \$50.70 | \$52.29 | \$15.45 | | \$118.44 | 0.813% |
| VERMONT | \$17.84 | \$17.16 | | \$35.00 | \$17.87 | | \$1.78 | \$54.65 | 0.375% |
| VIRGINIA | \$174.51 | | | \$174.51 | \$193.84 | | | \$368.36 | 2.529% |
| WASHINGTON | \$140.32 | | | \$140.32 | \$132.17 | | | \$272.49 | 1.870% |
| WEST VIRGINIA | \$59.83 | | | \$59.83 | \$60.22 | | | \$120.05 | 0.824% |
| WISCONSIN | \$147.32 | | | \$147.32 | \$142.56 | | | \$289.88 | 1.990% |
| WYOMING | \$35.34 | | | \$35.34 | \$34.73 | \$24.53 | | \$94.60 | 0.649% |
| US TOTAL | \$7,000.00 | \$118.01 | \$0.26 | \$7,118.28 | \$7,100.00 | \$246.42 | \$103.20 | \$14,567.90 | 100% |

CHANDLER B

FEDERAL PROGRAM CATEGORIES:

Categorical Program: 50% of Federal Funds

Flexible Program: 50% of Federal Funds

FORMULAS:

| | | | |
|----------------------|-------|--------------|-----------------------|
| Categorical Program: | 0 | Proportional | Bridge Deck Area |
| | 0 | " | Bridge Cost Share |
| | 11.4% | " | Rural Lane Miles |
| | 22.8% | " | Urban Lane Miles |
| | 11.4% | " | Rural VMT |
| | 22.8% | " | Urban VMT |
| | 31.6% | " | Diesel Fuel Purchases |

100.0% of Categorical Program Federal Apportionments

Flexible Program: Proportional Contributions to Highway Trust Fund

Density Factor: Increase Categorical and Flexible Funds By:

| Percent Increase | Persons Per Sq. Mile |
|------------------|----------------------|
| 35% | Fewer than 5 |
| 30% | 5 to 9.9 |
| 25% | 10 to 14.9 |
| 20% | 15 to 19.9 |
| 15% | 20 to 24.9 |
| 10% | 25 to 29.9 |
| 0% | 30 or More |

GUARANTEED FEDERAL FUNDING OF NO LESS THAN:

Half Percent: Half Percent of Categorical Program Apportionments

Minimum Allocation: Percent Categorical Apportionments No Less Than 85% of that State's Percent Contributions.

Hold Harmless: FY 1992 and Subsequent Total Federal Funding No Less Than FY 1991 Dollar Amount (less Interstate Completion above half percent, Interstate Transfer, Discretionary and Demonstration Projects) of Federal Highway Funds.

\$14.5 Billion level

CHANDLER B

ALLOCATION FORMULA

CATEGORICAL PROGRAM DETAIL

| STATE | Bridge Factors | | Lane Miles | | VMT | | Diesel Fuels | Total Allocation | % of Total |
|----------------|-----------------|------------------|------------|------------|----------|------------|--------------|------------------|------------|
| | Total Deck Area | Total Cost Share | Rural | Urban | Rural | Urban | | | |
| ALABAMA | \$0.00 | \$0.00 | \$18.80 | \$35.54 | \$20.49 | \$24.83 | \$52.80 | \$152.45 | 2.18% |
| ALASKA | \$0.00 | \$0.00 | \$2.58 | \$3.57 | \$2.05 | \$2.32 | \$4.75 | \$15.27 | 0.22% |
| ARIZONA | \$0.00 | \$0.00 | \$15.25 | \$26.60 | \$13.35 | \$27.28 | \$33.31 | \$115.79 | 1.65% |
| ARKANSAS | \$0.00 | \$0.00 | \$17.48 | \$15.99 | \$11.97 | \$9.25 | \$42.84 | \$97.53 | 1.39% |
| CALIFORNIA | \$0.00 | \$0.00 | \$23.74 | \$164.93 | \$49.98 | \$252.31 | \$195.42 | \$686.39 | 9.81% |
| COLORADO | \$0.00 | \$0.00 | \$16.75 | \$24.27 | \$10.72 | \$22.13 | \$20.98 | \$94.85 | 1.36% |
| CONNECTICUT | \$0.00 | \$0.00 | \$2.31 | \$22.77 | \$6.41 | \$25.85 | \$22.78 | \$80.12 | 1.14% |
| DELAWARE | \$0.00 | \$0.00 | \$1.00 | \$3.47 | \$2.84 | \$4.64 | \$6.15 | \$18.10 | 0.26% |
| D.C. | \$0.00 | \$0.00 | \$0.00 | \$2.58 | \$0.00 | \$4.51 | \$2.56 | \$9.65 | 0.14% |
| FLORIDA | \$0.00 | \$0.00 | \$14.84 | \$102.12 | \$28.86 | \$100.43 | \$85.69 | \$331.94 | 4.74% |
| GEORGIA | \$0.00 | \$0.00 | \$22.23 | \$43.77 | \$28.70 | \$43.62 | \$92.30 | \$230.62 | 3.29% |
| HAWAII | \$0.00 | \$0.00 | \$0.67 | \$3.27 | \$2.28 | \$6.74 | \$2.52 | \$15.49 | 0.22% |
| IDAH0 | \$0.00 | \$0.00 | \$14.73 | \$5.09 | \$5.48 | \$3.34 | \$11.06 | \$39.71 | 0.57% |
| ILLINOIS | \$0.00 | \$0.00 | \$26.55 | \$68.69 | \$24.11 | \$71.32 | \$85.83 | \$276.49 | 3.95% |
| INDIANA | \$0.00 | \$0.00 | \$19.08 | \$37.31 | \$27.90 | \$29.95 | \$69.80 | \$184.04 | 2.63% |
| IOWA | \$0.00 | \$0.00 | \$26.27 | \$18.98 | \$13.70 | \$10.47 | \$37.16 | \$106.58 | 1.52% |
| KANSAS | \$0.00 | \$0.00 | \$31.33 | \$18.56 | \$11.74 | \$12.14 | \$33.18 | \$106.94 | 1.53% |
| KENTUCKY | \$0.00 | \$0.00 | \$15.91 | \$16.26 | \$18.17 | \$17.28 | \$56.34 | \$123.97 | 1.77% |
| LOUISIANA | \$0.00 | \$0.00 | \$11.83 | \$26.68 | \$16.82 | \$23.17 | \$41.06 | \$119.57 | 1.71% |
| MAINE | \$0.00 | \$0.00 | \$4.98 | \$4.92 | \$8.16 | \$4.06 | \$12.78 | \$34.90 | 0.50% |
| MARYLAND | \$0.00 | \$0.00 | \$4.26 | \$26.73 | \$12.49 | \$32.76 | \$36.16 | \$112.40 | 1.61% |
| MASSACHUSETTS | \$0.00 | \$0.00 | \$3.39 | \$42.80 | \$7.66 | \$47.02 | \$32.24 | \$133.11 | 1.90% |
| MICHIGAN | \$0.00 | \$0.00 | \$23.14 | \$59.46 | \$30.11 | \$62.42 | \$58.41 | \$233.54 | 3.34% |
| MINNESOTA | \$0.00 | \$0.00 | \$29.33 | \$29.95 | \$16.76 | \$25.59 | \$36.83 | \$138.46 | 1.98% |
| MISSISSIPPI | \$0.00 | \$0.00 | \$16.56 | \$15.37 | \$14.52 | \$9.54 | \$35.39 | \$91.38 | 1.31% |
| MISSOURI | \$0.00 | \$0.00 | \$26.51 | \$33.08 | \$21.42 | \$31.37 | \$59.45 | \$171.81 | 2.45% |
| MONTANA | \$0.00 | \$0.00 | \$17.56 | \$4.55 | \$5.96 | \$2.71 | \$12.87 | \$43.64 | 0.62% |
| NEBRASKA | \$0.00 | \$0.00 | \$22.04 | \$10.36 | \$8.30 | \$6.52 | \$22.32 | \$69.54 | 0.99% |
| NEVADA | \$0.00 | \$0.00 | \$10.61 | \$6.94 | \$3.80 | \$6.76 | \$12.84 | \$40.94 | 0.58% |
| NEW HAMPSHIRE | \$0.00 | \$0.00 | \$3.15 | \$4.92 | \$5.73 | \$4.83 | \$6.45 | \$25.08 | 0.36% |
| NEW JERSEY | \$0.00 | \$0.00 | \$3.09 | \$47.39 | \$10.60 | \$63.36 | \$56.84 | \$181.28 | 2.59% |
| MEXICO | \$0.00 | \$0.00 | \$12.70 | \$10.34 | \$9.11 | \$7.91 | \$22.73 | \$62.79 | 0.90% |
| OK | \$0.00 | \$0.00 | \$18.72 | \$81.28 | \$29.51 | \$97.40 | \$77.27 | \$304.17 | 4.35% |
| CAROLINA | \$0.00 | \$0.00 | \$19.27 | \$39.30 | \$31.13 | \$34.61 | \$68.06 | \$192.37 | 2.75% |
| ORTH DAKOTA | \$0.00 | \$0.00 | \$21.37 | \$3.74 | \$4.13 | \$2.04 | \$10.11 | \$41.39 | 0.59% |
| OHIO | \$0.00 | \$0.00 | \$21.15 | \$67.41 | \$34.27 | \$62.21 | \$95.64 | \$280.68 | 4.01% |
| OKLAHOMA | \$0.00 | \$0.00 | \$25.24 | \$26.26 | \$15.86 | \$21.44 | \$42.96 | \$131.75 | 1.88% |
| OREGON | \$0.00 | \$0.00 | \$21.49 | \$18.27 | \$13.54 | \$15.05 | \$33.57 | \$101.93 | 1.46% |
| PENNSYLVANIA | \$0.00 | \$0.00 | \$22.72 | \$59.01 | \$35.94 | \$58.95 | \$103.05 | \$279.68 | 4.00% |
| RHODE ISLAND | \$0.00 | \$0.00 | \$0.39 | \$9.17 | \$0.89 | \$6.55 | \$4.84 | \$21.83 | 0.31% |
| SOUTH CAROLINA | \$0.00 | \$0.00 | \$14.01 | \$20.19 | \$19.93 | \$15.09 | \$34.46 | \$103.68 | 1.48% |
| SOUTH DAKOTA | \$0.00 | \$0.00 | \$18.16 | \$3.74 | \$4.99 | \$2.03 | \$10.49 | \$39.41 | 0.56% |
| TENNESSEE | \$0.00 | \$0.00 | \$17.47 | \$32.79 | \$20.99 | \$30.13 | \$63.77 | \$165.14 | 2.36% |
| TEXAS | \$0.00 | \$0.00 | \$55.89 | \$179.71 | \$52.56 | \$136.08 | \$147.58 | \$571.82 | 8.17% |
| UTAH | \$0.00 | \$0.00 | \$9.62 | \$11.73 | \$4.96 | \$10.85 | \$16.56 | \$53.73 | 0.77% |
| VERMONT | \$0.00 | \$0.00 | \$3.37 | \$1.99 | \$4.19 | \$1.69 | \$5.05 | \$16.28 | 0.23% |
| VIRGINIA | \$0.00 | \$0.00 | \$13.66 | \$32.54 | \$26.01 | \$40.89 | \$63.14 | \$176.24 | 2.52% |
| WASHINGTON | \$0.00 | \$0.00 | \$16.55 | \$35.07 | \$14.96 | \$35.12 | \$37.70 | \$139.40 | 1.99% |
| WEST VIRGINIA | \$0.00 | \$0.00 | \$8.08 | \$6.23 | \$9.78 | \$5.15 | \$20.62 | \$49.86 | 0.71% |
| WISCONSIN | \$0.00 | \$0.00 | \$24.32 | \$30.25 | \$21.94 | \$26.54 | \$46.51 | \$149.56 | 2.14% |
| WYOMING | \$0.00 | \$0.00 | \$9.88 | \$4.02 | \$4.24 | \$1.76 | \$16.80 | \$36.70 | 0.52% |
| US TOTAL | \$0.00 | \$0.00 | \$800.00 | \$1,600.00 | \$800.00 | \$1,600.00 | \$2,200.00 | \$7,000.00 | 100% |

\$14.5 Billion Level

CHANDLER B

ALLOCATION FORMULA

SUMMARY FUNDING

| STATE | Categorical Program | | | Total | Flexible Program | Density Factor | Hold Harmless | Total Funding | % of Total Funding |
|----------------|---------------------|----------|--------|------------|------------------|----------------|---------------|---------------|--------------------|
| | Formula | Half % | 85% MA | | | | | | |
| ALABAMA | \$152.45 | | | \$152.45 | \$140.28 | | | \$292.73 | 2.008% |
| ALASKA | \$15.27 | \$19.73 | | \$35.00 | \$14.78 | \$17.42 | \$86.13 | \$153.34 | 1.052% |
| ARIZONA | \$115.79 | | | \$115.79 | \$111.25 | \$22.70 | | \$249.75 | 1.713% |
| ARKANSAS | \$97.53 | | | \$97.53 | \$103.33 | | | \$200.85 | 1.378% |
| CALIFORNIA | \$686.39 | | | \$686.39 | \$746.59 | | | \$1,432.98 | 9.829% |
| COLORADO | \$94.85 | | | \$94.85 | \$86.38 | | | \$181.23 | 1.243% |
| CONNECTICUT | \$80.12 | | | \$80.12 | \$84.66 | | | \$164.77 | 1.130% |
| DELAWARE | \$18.10 | \$16.90 | | \$35.00 | \$21.59 | | | \$56.59 | 0.388% |
| D.C. | \$9.65 | \$25.35 | | \$35.00 | \$10.57 | | \$8.78 | \$54.34 | 0.373% |
| FLORIDA | \$331.94 | | | \$331.94 | \$340.92 | | | \$672.86 | 4.615% |
| GEORGIA | \$230.62 | | | \$230.62 | \$262.18 | | | \$492.80 | 3.380% |
| HAWAII | \$15.49 | \$19.51 | | \$35.00 | \$17.10 | | | \$52.10 | 0.357% |
| IDAHO | \$39.71 | | | \$39.71 | \$31.08 | \$17.70 | | \$88.48 | 0.607% |
| ILLINOIS | \$276.49 | | | \$276.49 | \$264.95 | | | \$541.44 | 3.714% |
| INDIANA | \$184.04 | | | \$184.04 | \$180.98 | | | \$365.02 | 2.504% |
| IOWA | \$106.58 | | | \$106.58 | \$90.03 | | | \$196.62 | 1.349% |
| KANSAS | \$106.94 | | | \$106.94 | \$91.48 | | | \$198.42 | 1.361% |
| KENTUCKY | \$123.97 | | | \$123.97 | \$127.01 | | | \$250.97 | 1.721% |
| LOUISIANA | \$119.57 | | | \$119.57 | \$131.54 | | | \$251.11 | 1.722% |
| MAINE | \$34.90 | \$0.10 | \$0.26 | \$35.26 | \$42.08 | | | \$77.34 | 0.530% |
| MARYLAND | \$112.40 | | | \$112.40 | \$128.79 | | | \$241.19 | 1.654% |
| MASSACHUSETTS | \$133.11 | | | \$133.11 | \$140.22 | | | \$273.33 | 1.875% |
| MICHIGAN | \$233.54 | | | \$233.54 | \$229.95 | | | \$463.49 | 3.179% |
| MINNESOTA | \$138.46 | | | \$138.46 | \$121.87 | | | \$260.33 | 1.786% |
| MISSISSIPPI | \$91.38 | | | \$91.38 | \$95.91 | | | \$187.28 | 1.285% |
| MISSOURI | \$171.81 | | | \$171.81 | \$183.02 | | | \$354.83 | 2.434% |
| MONTANA | \$43.64 | | | \$43.64 | \$33.97 | \$23.28 | \$6.24 | \$107.14 | 0.735% |
| NEBRASKA | \$69.54 | | | \$69.54 | \$51.98 | \$18.23 | | \$139.75 | 0.959% |
| NEVADA | \$40.94 | | | \$40.94 | \$38.90 | \$23.95 | | \$103.80 | 0.712% |
| NEW HAMPSHIRE | \$25.08 | \$9.92 | | \$35.00 | \$28.88 | | | \$63.88 | 0.438% |
| NEW JERSEY | \$181.28 | | | \$181.28 | \$209.63 | | | \$390.91 | 2.681% |
| NEW MEXICO | \$62.79 | | | \$62.79 | \$58.28 | \$30.27 | | \$151.34 | 1.038% |
| NEW YORK | \$304.17 | | | \$304.17 | \$324.02 | | | \$628.19 | 4.309% |
| NORTH CAROLINA | \$192.37 | | | \$192.37 | \$220.91 | | | \$413.28 | 2.835% |
| NORTH DAKOTA | \$41.39 | | | \$41.39 | \$25.26 | \$16.66 | | \$83.30 | 0.571% |
| OHIO | \$280.68 | | | \$280.68 | \$290.33 | | | \$571.01 | 3.917% |
| OKLAHOMA | \$131.75 | | | \$131.75 | \$121.21 | | | \$252.97 | 1.735% |
| OREGON | \$101.93 | | | \$101.93 | \$98.03 | \$20.00 | | \$219.96 | 1.509% |
| PENNSYLVANIA | \$279.68 | | | \$279.68 | \$322.15 | | | \$601.83 | 4.128% |
| RHODE ISLAND | \$21.83 | \$13.17 | | \$35.00 | \$21.54 | | | \$56.54 | 0.388% |
| SOUTH CAROLINA | \$103.68 | | | \$103.68 | \$103.50 | | | \$207.18 | 1.421% |
| SOUTH DAKOTA | \$39.41 | | | \$39.41 | \$26.82 | \$19.87 | | \$86.10 | 0.591% |
| TENNESSEE | \$165.14 | | | \$165.14 | \$166.74 | | | \$331.88 | 2.276% |
| TEXAS | \$571.82 | | | \$571.82 | \$525.64 | | | \$1,097.47 | 7.528% |
| UTAH | \$53.73 | | | \$53.73 | \$52.29 | \$15.90 | | \$121.92 | 0.836% |
| VERMONT | \$16.28 | \$18.72 | | \$35.00 | \$17.87 | | \$1.78 | \$54.65 | 0.375% |
| VIRGINIA | \$176.24 | | | \$176.24 | \$193.84 | | | \$370.09 | 2.539% |
| WASHINGTON | \$139.40 | | | \$139.40 | \$132.17 | | | \$271.58 | 1.863% |
| WEST VIRGINIA | \$49.86 | | \$0.61 | \$50.46 | \$60.22 | | \$0.86 | \$111.54 | 0.765% |
| WISCONSIN | \$149.56 | | | \$149.56 | \$142.56 | | | \$292.12 | 2.004% |
| WYOMING | \$36.70 | | | \$36.70 | \$34.73 | \$25.00 | | \$96.43 | 0.661% |
| US TOTAL | \$7,000.00 | \$123.41 | \$0.87 | \$7,124.27 | \$7,100.00 | \$250.99 | \$103.79 | \$14,579.04 | 100% |

CHANDLER C

FEDERAL PROGRAM CATEGORIES:

Categorical Program: 50% of Federal Funds
Flexible Program: 50% of Federal Funds

FORMULAS:

Categorical Program: 5.7% Proportional Bridge Deck Area
5.7% " Bridge Cost Share
10.0% " Rural Lane Miles
20.0% " Urban Lane Miles
10.0% " Rural VMT
20.0% " Urban VMT
28.6% " Diesel Fuel Purchases
100.0% of Categorical Program Federal Apportionments
Flexible Program: Proportional Contributions to Highway Trust Fund
Density Factor: No Density Factor

GUARANTEED FEDERAL FUNDING OF NO LESS THAN:

Half Percent: Half Percent of Categorical Program Apportionments
Minimum Allocation: Percent Categorical Apportionments No Less Than 85% of that State's Percent Contributions.
Hold Harmless: FY 1992 and Subsequent Total Federal Funding No Less Than FY 1991 Dollar Amount (less Interstate Completion above half percent, Interstate Transfer, Discretionary and Demonstration Projects) of Federal Highway Funds.

\$14.5 Billion level

CHANDLER C

ALLOCATION FORMULA

CATEGORICAL PROGRAM DETAIL

| STATE | Bridge Factors | | Lane Miles | | VMT | | Diesel Fuels | Total Allocation | % of Total |
|----------------|--------------------|---------------------|------------|------------|----------|------------|-----------------|---------------------|---------------|
| | Total Deck Area | Total Cost Share | Rural | Urban | Rural | Urban | | | |
| ALABAMA | \$10.11 | \$8.66 | \$16.45 | \$31.10 | \$17.93 | \$21.73 | \$50.40 | \$156.36 | 2.20% |
| ALASKA | \$0.74 | \$1.00 | \$2.25 | \$3.13 | \$1.79 | \$2.03 | \$4.54 | \$15.48 | 0.22% |
| ARIZONA | \$3.60 | \$1.00 | \$13.34 | \$23.27 | \$11.69 | \$23.87 | \$31.79 | \$108.57 | 1.53% |
| ARKANSAS | \$7.28 | \$5.01 | \$15.29 | \$13.99 | \$10.48 | \$8.09 | \$40.89 | \$101.03 | 1.42% |
| CALIFORNIA | \$31.99 | \$13.01 | \$20.78 | \$144.32 | \$43.73 | \$220.77 | \$186.54 | \$661.13 | 9.31% |
| COLORADO | \$5.13 | \$4.06 | \$14.66 | \$21.24 | \$9.38 | \$19.36 | \$20.02 | \$93.86 | 1.32% |
| CONNECTICUT | \$4.28 | \$17.81 | \$2.02 | \$19.92 | \$5.61 | \$22.62 | \$21.75 | \$94.00 | 1.32% |
| DELAWARE | \$1.13 | \$1.18 | \$0.87 | \$3.04 | \$2.49 | \$4.06 | \$5.87 | \$18.63 | 0.26% |
| D.C. | \$0.78 | \$3.17 | \$0.00 | \$2.26 | \$0.00 | \$3.95 | \$2.44 | \$12.60 | 0.18% |
| FLORIDA | \$15.20 | \$6.64 | \$12.98 | \$89.36 | \$25.25 | \$87.88 | \$81.80 | \$319.10 | 4.49% |
| GEORGIA | \$10.20 | \$8.18 | \$19.45 | \$38.30 | \$25.11 | \$38.17 | \$88.10 | \$227.51 | 3.20% |
| HAWAII | \$1.16 | \$1.32 | \$0.59 | \$2.86 | \$1.99 | \$5.90 | \$2.41 | \$16.23 | 0.23% |
| IDAHO | \$1.88 | \$1.00 | \$12.89 | \$4.45 | \$4.80 | \$2.93 | \$10.56 | \$38.50 | 0.54% |
| ILLINOIS | \$16.53 | \$11.73 | \$23.23 | \$60.10 | \$21.10 | \$62.40 | \$81.93 | \$277.01 | 3.90% |
| INDIANA | \$9.08 | \$6.80 | \$16.70 | \$32.65 | \$24.41 | \$26.21 | \$66.63 | \$182.47 | 2.57% |
| IOWA | \$9.54 | \$7.30 | \$22.99 | \$16.61 | \$11.99 | \$9.16 | \$35.47 | \$113.06 | 1.59% |
| KANSAS | \$10.46 | \$7.66 | \$27.41 | \$16.24 | \$10.27 | \$10.62 | \$31.67 | \$114.33 | 1.61% |
| KENTUCKY | \$6.58 | \$8.02 | \$13.93 | \$14.23 | \$15.90 | \$15.12 | \$53.78 | \$127.55 | 1.80% |
| LOUISIANA | \$16.84 | \$9.24 | \$10.35 | \$23.35 | \$14.71 | \$20.28 | \$39.20 | \$133.97 | 1.89% |
| MAINE | \$1.50 | \$2.50 | \$4.36 | \$4.31 | \$7.14 | \$3.55 | \$12.20 | \$35.56 | 0.50% |
| MARYLAND | \$5.67 | \$5.17 | \$3.73 | \$23.39 | \$10.93 | \$28.66 | \$34.52 | \$112.06 | 1.58% |
| MASSACHUSETTS | \$5.52 | \$20.72 | \$2.96 | \$37.45 | \$6.71 | \$41.14 | \$30.78 | \$145.29 | 2.05% |
| MICHIGAN | \$8.21 | \$9.16 | \$20.25 | \$52.03 | \$26.34 | \$54.62 | \$55.75 | \$226.37 | 3.19% |
| MINNESOTA | \$7.34 | \$5.00 | \$25.66 | \$26.21 | \$14.66 | \$22.39 | \$35.15 | \$136.42 | 1.92% |
| MISSISSIPPI | \$8.92 | \$5.96 | \$14.49 | \$13.45 | \$12.70 | \$8.35 | \$33.78 | \$97.65 | 1.38% |
| MISSOURI | \$10.81 | \$16.22 | \$23.19 | \$28.94 | \$18.74 | \$27.45 | \$56.75 | \$182.10 | 2.56% |
| MONTANA | \$2.72 | \$2.09 | \$15.36 | \$3.98 | \$5.22 | \$2.37 | \$12.28 | \$44.01 | 0.62% |
| NEBRASKA | \$4.65 | \$4.84 | \$19.29 | \$9.06 | \$7.26 | \$5.71 | \$21.30 | \$72.12 | 1.02% |
| NEVADA | \$1.15 | \$1.00 | \$9.28 | \$6.07 | \$3.33 | \$5.91 | \$12.26 | \$39.00 | 0.55% |
| NEW HAMPSHIRE | \$1.39 | \$2.17 | \$2.75 | \$4.31 | \$5.02 | \$4.23 | \$6.15 | \$26.02 | 0.37% |
| NEW JERSEY | \$8.63 | \$17.70 | \$2.70 | \$41.47 | \$9.28 | \$55.44 | \$54.26 | \$189.47 | 2.67% |
| NEW MEXICO | \$1.95 | \$1.32 | \$11.11 | \$9.05 | \$7.97 | \$6.92 | \$21.70 | \$60.02 | 0.85% |
| NEW YORK | \$18.57 | \$40.12 | \$16.38 | \$71.12 | \$25.82 | \$85.22 | \$73.76 | \$330.98 | 4.66% |
| NORTH CAROLINA | \$8.83 | \$8.25 | \$16.86 | \$34.39 | \$27.24 | \$30.29 | \$64.97 | \$190.82 | 2.69% |
| NORTH DAKOTA | \$1.64 | \$1.48 | \$18.70 | \$3.27 | \$3.62 | \$1.79 | \$9.65 | \$40.13 | 0.57% |
| OHIO | \$16.85 | \$12.56 | \$18.51 | \$58.99 | \$29.99 | \$54.43 | \$91.30 | \$282.62 | 3.98% |
| OKLAHOMA | \$10.26 | \$9.30 | \$22.08 | \$22.98 | \$13.87 | \$18.76 | \$41.01 | \$138.26 | 1.95% |
| OREGON | \$6.00 | \$2.21 | \$18.81 | \$15.99 | \$11.85 | \$13.17 | \$32.05 | \$100.07 | 1.41% |
| PENNSYLVANIA | \$16.18 | \$35.43 | \$19.88 | \$51.64 | \$31.45 | \$51.58 | \$98.37 | \$304.52 | 4.29% |
| RHODE ISLAND | \$0.97 | \$1.00 | \$0.34 | \$8.02 | \$0.77 | \$5.73 | \$4.62 | \$21.46 | 0.30% |
| SOUTH CAROLINA | \$6.38 | \$3.38 | \$12.26 | \$17.67 | \$17.44 | \$13.20 | \$32.89 | \$103.22 | 1.45% |
| SOUTH DAKOTA | \$2.48 | \$1.98 | \$15.89 | \$3.27 | \$4.37 | \$1.78 | \$10.01 | \$39.79 | 0.56% |
| TENNESSEE | \$10.10 | \$10.95 | \$15.28 | \$28.69 | \$18.36 | \$26.36 | \$60.87 | \$170.62 | 2.40% |
| TEXAS | \$36.96 | \$15.77 | \$48.90 | \$157.25 | \$45.99 | \$119.07 | \$140.87 | \$564.81 | 7.96% |
| UTAH | \$2.12 | \$1.00 | \$8.42 | \$10.27 | \$4.34 | \$9.49 | \$15.80 | \$51.45 | 0.72% |
| VERMONT | \$1.18 | \$2.25 | \$2.95 | \$1.74 | \$3.66 | \$1.48 | \$4.82 | \$18.07 | 0.25% |
| VIRGINIA | \$9.30 | \$8.84 | \$11.95 | \$28.47 | \$22.76 | \$35.77 | \$60.27 | \$177.38 | 2.50% |
| WASHINGTON | \$7.90 | \$9.16 | \$14.48 | \$30.68 | \$13.09 | \$30.73 | \$35.99 | \$142.03 | 2.00% |
| WEST VIRGINIA | \$3.96 | \$11.54 | \$7.07 | \$5.45 | \$8.56 | \$4.51 | \$19.68 | \$60.77 | 0.86% |
| WISCONSIN | \$7.74 | \$7.13 | \$21.28 | \$26.47 | \$19.19 | \$23.22 | \$44.40 | \$149.44 | 2.10% |
| WYOMING | \$1.66 | \$1.00 | \$8.64 | \$3.52 | \$3.71 | \$1.54 | \$16.04 | \$36.11 | 0.51% |
| US TOTAL | \$400.00 | \$400.00 | \$700.00 | \$1,400.00 | \$700.00 | \$1,400.00 | \$2,100.00 | \$7,100.00 | 100% |

\$14.5 Billion Level

CHANDLER C

ALLOCATION FORMULA

SUMMARY FUNDING

| STATE | Categorical Program | | | | Flexible Program | Density Factor | Hold Harmless | Total Funding | % of Total Funding |
|----------------|---------------------|----------|--------|------------|------------------|----------------|---------------|---------------|--------------------|
| | Formula | Half % | 85% MA | Total | | | | | |
| ALABAMA | \$156.36 | | | \$156.36 | \$142.26 | | | \$298.62 | 2.046% |
| ALASKA | \$15.48 | \$20.02 | | \$35.50 | \$14.99 | | \$102.84 | \$153.34 | 1.051% |
| ARIZONA | \$108.57 | | | \$108.57 | \$112.82 | | | \$221.39 | 1.517% |
| ARKANSAS | \$101.03 | | | \$101.03 | \$104.78 | | | \$205.82 | 1.410% |
| CALIFORNIA | \$661.13 | | | \$661.13 | \$757.11 | | | \$1,418.24 | 9.719% |
| COLORADO | \$93.86 | | | \$93.86 | \$87.59 | | | \$181.45 | 1.243% |
| CONNECTICUT | \$94.00 | | | \$94.00 | \$85.85 | | | \$179.85 | 1.232% |
| DELAWARE | \$18.63 | \$16.87 | | \$35.50 | \$21.89 | | | \$57.39 | 0.393% |
| D.C. | \$12.60 | \$22.90 | | \$35.50 | \$10.72 | | \$8.13 | \$54.34 | 0.372% |
| FLORIDA | \$319.10 | | | \$319.10 | \$345.72 | | | \$664.82 | 4.556% |
| GEORGIA | \$227.51 | | | \$227.51 | \$265.87 | | | \$493.38 | 3.381% |
| HAWAII | \$16.23 | \$19.27 | | \$35.50 | \$17.34 | | | \$52.84 | 0.362% |
| IDAHO | \$38.50 | | | \$38.50 | \$31.52 | | \$2.97 | \$72.99 | 0.500% |
| ILLINOIS | \$277.01 | | | \$277.01 | \$268.68 | | | \$545.69 | 3.740% |
| INDIANA | \$182.47 | | | \$182.47 | \$183.53 | | | \$366.00 | 2.508% |
| IOWA | \$113.06 | | | \$113.06 | \$91.30 | | | \$204.36 | 1.400% |
| KANSAS | \$114.33 | | | \$114.33 | \$92.77 | | | \$207.10 | 1.419% |
| KENTUCKY | \$127.55 | | | \$127.55 | \$128.80 | | | \$256.34 | 1.757% |
| LOUISIANA | \$133.97 | | | \$133.97 | \$133.40 | | | \$267.36 | 1.832% |
| MAINE | \$35.56 | | \$0.21 | \$35.76 | \$42.67 | | | \$78.43 | 0.537% |
| MARYLAND | \$112.06 | | | \$112.06 | \$130.61 | | | \$242.67 | 1.663% |
| MASSACHUSETTS | \$145.29 | | | \$145.29 | \$142.20 | | | \$287.48 | 1.970% |
| MICHIGAN | \$226.37 | | | \$226.37 | \$233.19 | | | \$459.56 | 3.149% |
| MINNESOTA | \$136.42 | | | \$136.42 | \$123.59 | | | \$260.00 | 1.782% |
| MISSISSIPPI | \$97.65 | | | \$97.65 | \$97.26 | | | \$194.91 | 1.336% |
| MISSOURI | \$182.10 | | | \$182.10 | \$185.59 | | | \$367.69 | 2.520% |
| MONTANA | \$44.01 | | | \$44.01 | \$34.45 | | \$28.67 | \$107.14 | 0.734% |
| NEBRASKA | \$72.12 | | | \$72.12 | \$52.72 | | | \$124.83 | 0.855% |
| NEVADA | \$39.00 | | | \$39.00 | \$39.45 | | | \$78.45 | 0.538% |
| NEW HAMPSHIRE | \$26.02 | \$9.48 | | \$35.50 | \$29.29 | | | \$64.79 | 0.444% |
| NEW JERSEY | \$189.47 | | | \$189.47 | \$212.58 | | | \$402.04 | 2.755% |
| NEW MEXICO | \$60.02 | | | \$60.02 | \$59.10 | | | \$119.13 | 0.816% |
| NEW YORK | \$330.98 | | | \$330.98 | \$328.58 | | | \$659.56 | 4.520% |
| NORTH CAROLINA | \$190.82 | | | \$190.82 | \$224.02 | | | \$414.84 | 2.843% |
| NORTH DAKOTA | \$40.13 | | | \$40.13 | \$25.61 | | \$6.58 | \$72.32 | 0.496% |
| OHIO | \$282.62 | | | \$282.62 | \$294.42 | | | \$577.03 | 3.954% |
| OKLAHOMA | \$138.26 | | | \$138.26 | \$122.92 | | | \$261.18 | 1.790% |
| OREGON | \$100.07 | | | \$100.07 | \$99.41 | | | \$199.49 | 1.367% |
| PENNSYLVANIA | \$304.52 | | | \$304.52 | \$326.69 | | | \$631.21 | 4.326% |
| RHODE ISLAND | \$21.46 | \$14.04 | | \$35.50 | \$21.85 | | | \$57.35 | 0.393% |
| SOUTH CAROLINA | \$103.22 | | | \$103.22 | \$104.96 | | | \$208.17 | 1.427% |
| SOUTH DAKOTA | \$39.79 | | | \$39.79 | \$27.20 | | \$12.45 | \$79.43 | 0.544% |
| TENNESSEE | \$170.62 | | | \$170.62 | \$169.09 | | | \$339.71 | 2.328% |
| TEXAS | \$564.81 | | | \$564.81 | \$533.05 | | | \$1,097.86 | 7.523% |
| UTAH | \$51.45 | | | \$51.45 | \$53.03 | | | \$104.48 | 0.716% |
| VERMONT | \$18.07 | \$17.43 | | \$35.50 | \$18.12 | | \$1.03 | \$54.65 | 0.375% |
| VIRGINIA | \$177.38 | | | \$177.38 | \$196.57 | | | \$373.96 | 2.563% |
| WASHINGTON | \$142.03 | | | \$142.03 | \$134.03 | | | \$276.07 | 1.892% |
| WEST VIRGINIA | \$60.77 | | | \$60.77 | \$61.07 | | | \$121.83 | 0.835% |
| WISCONSIN | \$149.44 | | | \$149.44 | \$144.57 | | | \$294.00 | 2.015% |
| MISSOURI | \$36.11 | | | \$36.11 | \$35.22 | | \$9.52 | \$80.85 | 0.554% |
| US TOTAL | \$7,100.00 | \$120.02 | \$0.21 | \$7,220.23 | \$7,200.00 | \$0.00 | \$172.19 | \$14,592.42 | 100% |

CHANDLER D

FEDERAL PROGRAM CATEGORIES:

Categorical Program: 50% of Federal Funds
Flexible Program: 50% of Federal Funds

FORMULAS:

Categorical Program: 0 Proportional Bridge Deck Area
0 " Bridge Cost Share
10.0% " Rural Lane Miles
20.0% " Urban Lane Miles
10.0% " Rural VMT
20.0% " Urban VMT
28.6% " Diesel Fuel Purchases
100.0% of Categorical Program Federal Apportionments
Flexible Program: Proportional Contributions to Highway Trust Fund
Density Factor: No Density Factor

GUARANTEED FEDERAL FUNDING OF NO LESS THAN:

Half Percent: Half Percent of Categorical Program Apportionments
Minimum Allocation: Percent Categorical Apportionments No Less Than 85% of that State's Percent Contributions.
Hold Harmless: FY 1992 and Subsequent Total Federal Funding No Less Than FY 1991 Dollar Amount (less Interstate Completion above half percent, Interstate Transfer, Discretionary and Demonstration Projects) of Federal Highway Funds.

\$14.5 Billion level

CHANDLER D

ALLOCATION FORMULA

CATEGORICAL PROGRAM DETAIL

| STATE | Bridge Factors | | Lane Miles | | VMT | | Diesel Fuels | Total Allocation | % of Total |
|----------------|--------------------|---------------------|------------|------------|----------|------------|-----------------|---------------------|---------------|
| | Total Deck Area | Total Cost Share | Rural | Urban | Rural | Urban | | | |
| | ===== | ===== | ===== | ===== | ===== | ===== | | | |
| ALABAMA | \$0.00 | \$0.00 | \$18.80 | \$35.54 | \$20.49 | \$24.83 | \$55.20 | \$154.85 | 2.18% |
| ALASKA | \$0.00 | \$0.00 | \$2.58 | \$3.57 | \$2.05 | \$2.32 | \$4.97 | \$15.48 | 0.22% |
| ARIZONA | \$0.00 | \$0.00 | \$15.25 | \$26.60 | \$13.35 | \$27.28 | \$34.82 | \$117.31 | 1.65% |
| ARKANSAS | \$0.00 | \$0.00 | \$17.48 | \$15.99 | \$11.97 | \$9.25 | \$44.78 | \$99.47 | 1.40% |
| CALIFORNIA | \$0.00 | \$0.00 | \$23.74 | \$164.93 | \$49.98 | \$252.31 | \$204.30 | \$695.27 | 9.79% |
| COLORADO | \$0.00 | \$0.00 | \$16.75 | \$24.27 | \$10.72 | \$22.13 | \$21.93 | \$95.81 | 1.35% |
| CONNECTICUT | \$0.00 | \$0.00 | \$2.31 | \$22.77 | \$6.41 | \$25.85 | \$23.82 | \$81.15 | 1.14% |
| DELAWARE | \$0.00 | \$0.00 | \$1.00 | \$3.47 | \$2.84 | \$4.64 | \$6.43 | \$18.38 | 0.26% |
| D.C. | \$0.00 | \$0.00 | \$0.00 | \$2.58 | \$0.00 | \$4.51 | \$2.67 | \$9.77 | 0.14% |
| FLORIDA | \$0.00 | \$0.00 | \$14.84 | \$102.12 | \$28.86 | \$100.43 | \$89.59 | \$335.84 | 4.73% |
| GEORGIA | \$0.00 | \$0.00 | \$22.23 | \$43.77 | \$28.70 | \$43.62 | \$96.49 | \$234.82 | 3.31% |
| HAWAII | \$0.00 | \$0.00 | \$0.67 | \$3.27 | \$2.28 | \$6.74 | \$2.64 | \$15.60 | 0.22% |
| IDAHO | \$0.00 | \$0.00 | \$14.73 | \$5.09 | \$5.48 | \$3.34 | \$11.56 | \$40.21 | 0.57% |
| ILLINOIS | \$0.00 | \$0.00 | \$26.55 | \$68.69 | \$24.11 | \$71.32 | \$89.73 | \$280.40 | 3.95% |
| INDIANA | \$0.00 | \$0.00 | \$19.08 | \$37.31 | \$27.90 | \$29.95 | \$72.97 | \$187.21 | 2.64% |
| IOWA | \$0.00 | \$0.00 | \$26.27 | \$18.98 | \$13.70 | \$10.47 | \$38.85 | \$108.27 | 1.52% |
| KANSAS | \$0.00 | \$0.00 | \$31.33 | \$18.56 | \$11.74 | \$12.14 | \$34.68 | \$108.45 | 1.53% |
| KENTUCKY | \$0.00 | \$0.00 | \$15.91 | \$16.26 | \$18.17 | \$17.28 | \$58.90 | \$126.53 | 1.78% |
| LOUISIANA | \$0.00 | \$0.00 | \$11.83 | \$26.68 | \$16.82 | \$23.17 | \$42.93 | \$121.43 | 1.71% |
| MAINE | \$0.00 | \$0.00 | \$4.98 | \$4.92 | \$8.16 | \$4.06 | \$13.36 | \$35.48 | 0.50% |
| MARYLAND | \$0.00 | \$0.00 | \$4.26 | \$26.73 | \$12.49 | \$32.76 | \$37.81 | \$114.04 | 1.61% |
| MASSACHUSETTS | \$0.00 | \$0.00 | \$3.39 | \$42.80 | \$7.66 | \$47.02 | \$33.71 | \$134.58 | 1.90% |
| MICHIGAN | \$0.00 | \$0.00 | \$23.14 | \$59.46 | \$30.11 | \$62.42 | \$61.06 | \$236.19 | 3.33% |
| MINNESOTA | \$0.00 | \$0.00 | \$29.33 | \$29.95 | \$16.76 | \$25.59 | \$38.50 | \$140.13 | 1.97% |
| MISSISSIPPI | \$0.00 | \$0.00 | \$16.56 | \$15.37 | \$14.52 | \$9.54 | \$37.00 | \$92.99 | 1.31% |
| MISSOURI | \$0.00 | \$0.00 | \$26.51 | \$33.08 | \$21.42 | \$31.37 | \$62.15 | \$174.52 | 2.46% |
| MONTANA | \$0.00 | \$0.00 | \$17.56 | \$4.55 | \$5.96 | \$2.71 | \$13.45 | \$44.23 | 0.62% |
| NEBRASKA | \$0.00 | \$0.00 | \$22.04 | \$10.36 | \$8.30 | \$6.52 | \$23.33 | \$70.55 | 0.99% |
| NEVADA | \$0.00 | \$0.00 | \$10.61 | \$6.94 | \$3.80 | \$6.76 | \$13.43 | \$41.53 | 0.58% |
| NEW HAMPSHIRE | \$0.00 | \$0.00 | \$3.15 | \$4.92 | \$5.73 | \$4.83 | \$6.74 | \$25.37 | 0.36% |
| NEW JERSEY | \$0.00 | \$0.00 | \$3.09 | \$47.39 | \$10.60 | \$63.36 | \$59.42 | \$183.86 | 2.59% |
| NEW MEXICO | \$0.00 | \$0.00 | \$12.70 | \$10.34 | \$9.11 | \$7.91 | \$23.76 | \$63.82 | 0.90% |
| NEW YORK | \$0.00 | \$0.00 | \$18.72 | \$81.28 | \$29.51 | \$97.40 | \$80.78 | \$307.68 | 4.33% |
| NORTH CAROLINA | \$0.00 | \$0.00 | \$19.27 | \$39.30 | \$31.13 | \$34.61 | \$71.16 | \$195.47 | 2.75% |
| NORTH DAKOTA | \$0.00 | \$0.00 | \$21.37 | \$3.74 | \$4.13 | \$2.04 | \$10.57 | \$41.85 | 0.59% |
| OHIO | \$0.00 | \$0.00 | \$21.15 | \$67.41 | \$34.27 | \$62.21 | \$99.99 | \$285.03 | 4.01% |
| OKLAHOMA | \$0.00 | \$0.00 | \$25.24 | \$26.26 | \$15.86 | \$21.44 | \$44.92 | \$133.71 | 1.88% |
| OREGON | \$0.00 | \$0.00 | \$21.49 | \$18.27 | \$13.54 | \$15.05 | \$35.10 | \$103.46 | 1.46% |
| PENNSYLVANIA | \$0.00 | \$0.00 | \$22.72 | \$59.01 | \$35.94 | \$58.95 | \$107.74 | \$284.36 | 4.01% |
| RHODE ISLAND | \$0.00 | \$0.00 | \$0.39 | \$9.17 | \$0.89 | \$6.55 | \$5.06 | \$22.05 | 0.31% |
| SOUTH CAROLINA | \$0.00 | \$0.00 | \$14.01 | \$20.19 | \$19.93 | \$15.09 | \$36.03 | \$105.25 | 1.48% |
| SOUTH DAKOTA | \$0.00 | \$0.00 | \$18.16 | \$3.74 | \$4.99 | \$2.03 | \$10.96 | \$39.89 | 0.56% |
| TENNESSEE | \$0.00 | \$0.00 | \$17.47 | \$32.79 | \$20.99 | \$30.13 | \$66.66 | \$168.04 | 2.37% |
| TEXAS | \$0.00 | \$0.00 | \$55.89 | \$179.71 | \$52.56 | \$136.08 | \$154.29 | \$578.53 | 8.15% |
| UTAH | \$0.00 | \$0.00 | \$9.62 | \$11.73 | \$4.96 | \$10.85 | \$17.31 | \$54.48 | 0.77% |
| VERMONT | \$0.00 | \$0.00 | \$3.37 | \$1.99 | \$4.19 | \$1.69 | \$5.28 | \$16.51 | 0.23% |
| VIRGINIA | \$0.00 | \$0.00 | \$13.66 | \$32.54 | \$26.01 | \$40.89 | \$66.01 | \$179.11 | 2.52% |
| WASHINGTON | \$0.00 | \$0.00 | \$16.55 | \$35.07 | \$14.96 | \$35.12 | \$39.41 | \$141.12 | 1.99% |
| WEST VIRGINIA | \$0.00 | \$0.00 | \$8.08 | \$6.23 | \$9.78 | \$5.15 | \$21.55 | \$50.80 | 0.72% |
| WISCONSIN | \$0.00 | \$0.00 | \$24.32 | \$30.25 | \$21.94 | \$26.54 | \$48.62 | \$151.68 | 2.14% |
| WYOMING | \$0.00 | \$0.00 | \$9.88 | \$4.02 | \$4.24 | \$1.76 | \$17.56 | \$37.46 | 0.53% |
| US TOTAL | \$0.00 | \$0.00 | \$800.00 | \$1,600.00 | \$800.00 | \$1,600.00 | \$2,300.00 | \$7,100.00 | 100% |

\$14.5 Billion Level

CHANDLER D

ALLOCATION FORMULA

SUMMARY FUNDING

| STATE | Categorical Program | | | | Flexible Program | Density Factor | Hold Harmless | Total Funding | % of Total Funding |
|----------------|---------------------|----------|--------|------------|------------------|----------------|---------------|---------------|--------------------|
| | Formula | Half % | 85% MA | Total | | | | | |
| ALABAMA | \$154.85 | | | \$154.85 | \$142.26 | | | \$297.11 | 2.036% |
| ALASKA | \$15.48 | \$20.02 | | \$35.50 | \$14.99 | | \$102.84 | \$153.34 | 1.051% |
| ARIZONA | \$117.31 | | | \$117.31 | \$112.82 | | | \$230.12 | 1.577% |
| ARKANSAS | \$99.47 | | | \$99.47 | \$104.78 | | | \$204.26 | 1.400% |
| CALIFORNIA | \$695.27 | | | \$695.27 | \$757.11 | | | \$1,452.37 | 9.952% |
| COLORADO | \$95.81 | | | \$95.81 | \$87.59 | | | \$183.40 | 1.257% |
| CONNECTICUT | \$81.15 | | | \$81.15 | \$85.85 | | | \$167.00 | 1.144% |
| DELAWARE | \$18.38 | \$17.12 | | \$35.50 | \$21.89 | | | \$57.39 | 0.393% |
| D.C. | \$9.77 | \$25.73 | | \$35.50 | \$10.72 | | \$8.13 | \$54.34 | 0.372% |
| FLORIDA | \$335.84 | | | \$335.84 | \$345.72 | | | \$681.56 | 4.670% |
| GEORGIA | \$234.82 | | | \$234.82 | \$265.87 | | | \$500.68 | 3.431% |
| HAWAII | \$15.60 | \$19.90 | | \$35.50 | \$17.34 | | | \$52.84 | 0.362% |
| IDAHO | \$40.21 | | | \$40.21 | \$31.52 | | \$1.27 | \$72.99 | 0.500% |
| ILLINOIS | \$280.40 | | | \$280.40 | \$268.68 | | | \$549.07 | 3.763% |
| INDIANA | \$187.21 | | | \$187.21 | \$183.53 | | | \$370.74 | 2.541% |
| IOWA | \$108.27 | | | \$108.27 | \$91.30 | | | \$199.57 | 1.368% |
| KANSAS | \$108.45 | | | \$108.45 | \$92.77 | | | \$201.22 | 1.379% |
| KENTUCKY | \$126.53 | | | \$126.53 | \$128.80 | | | \$255.32 | 1.750% |
| LOUISIANA | \$121.43 | | | \$121.43 | \$133.40 | | | \$254.83 | 1.746% |
| MAINE | \$35.48 | \$0.02 | \$0.26 | \$35.76 | \$42.67 | | | \$78.43 | 0.537% |
| MARYLAND | \$114.04 | | | \$114.04 | \$130.61 | | | \$244.65 | 1.676% |
| MASSACHUSETTS | \$134.58 | | | \$134.58 | \$142.20 | | | \$276.77 | 1.897% |
| MICHIGAN | \$236.19 | | | \$236.19 | \$233.19 | | | \$469.38 | 3.216% |
| MINNESOTA | \$140.13 | | | \$140.13 | \$123.59 | | | \$263.72 | 1.807% |
| MISSISSIPPI | \$92.99 | | | \$92.99 | \$97.26 | | | \$190.24 | 1.304% |
| MISSOURI | \$174.52 | | | \$174.52 | \$185.59 | | | \$360.11 | 2.468% |
| MONTANA | \$44.23 | | | \$44.23 | \$34.45 | | \$28.46 | \$107.14 | 0.734% |
| NEBRASKA | \$70.55 | | | \$70.55 | \$52.72 | | | \$123.27 | 0.845% |
| NEVADA | \$41.53 | | | \$41.53 | \$39.45 | | | \$80.98 | 0.555% |
| NEW HAMPSHIRE | \$25.37 | \$10.13 | | \$35.50 | \$29.29 | | | \$64.79 | 0.444% |
| NEW JERSEY | \$183.86 | | | \$183.86 | \$212.58 | | | \$396.44 | 2.717% |
| NEW MEXICO | \$63.82 | | | \$63.82 | \$59.10 | | | \$122.93 | 0.842% |
| NEW YORK | \$307.68 | | | \$307.68 | \$328.58 | | | \$636.26 | 4.360% |
| NORTH CAROLINA | \$195.47 | | | \$195.47 | \$224.02 | | | \$419.49 | 2.875% |
| NORTH DAKOTA | \$41.85 | | | \$41.85 | \$25.61 | | \$4.86 | \$72.32 | 0.496% |
| OHIO | \$285.03 | | | \$285.03 | \$294.42 | | | \$579.44 | 3.971% |
| OKLAHOMA | \$133.71 | | | \$133.71 | \$122.92 | | | \$256.63 | 1.759% |
| OREGON | \$103.46 | | | \$103.46 | \$99.41 | | | \$202.87 | 1.390% |
| PENNSYLVANIA | \$284.36 | | | \$284.36 | \$326.69 | | | \$611.05 | 4.187% |
| RHODE ISLAND | \$22.05 | \$13.45 | | \$35.50 | \$21.85 | | | \$57.35 | 0.393% |
| SOUTH CAROLINA | \$105.25 | | | \$105.25 | \$104.96 | | | \$210.20 | 1.440% |
| SOUTH DAKOTA | \$39.89 | | | \$39.89 | \$27.20 | | \$12.35 | \$79.43 | 0.544% |
| TENNESSEE | \$168.04 | | | \$168.04 | \$169.09 | | | \$337.13 | 2.310% |
| TEXAS | \$578.53 | | | \$578.53 | \$533.05 | | | \$1,111.58 | 7.617% |
| UTAH | \$54.48 | | | \$54.48 | \$53.03 | | | \$107.50 | 0.737% |
| VERMONT | \$16.51 | \$18.99 | | \$35.50 | \$18.12 | | \$1.03 | \$54.65 | 0.374% |
| VIRGINIA | \$179.11 | | | \$179.11 | \$196.57 | | | \$375.69 | 2.574% |
| WASHINGTON | \$141.12 | | | \$141.12 | \$134.03 | | | \$275.15 | 1.885% |
| WEST VIRGINIA | \$50.80 | | \$0.39 | \$51.19 | \$61.07 | | | \$112.25 | 0.769% |
| WISCONSIN | \$151.68 | | | \$151.68 | \$144.57 | | | \$296.24 | 2.030% |
| WYOMING | \$37.46 | | | \$37.46 | \$35.22 | | \$8.17 | \$80.85 | 0.554% |
| US TOTAL | \$7,100.00 | \$125.36 | \$0.65 | \$7,226.01 | \$7,200.00 | \$0.00 | \$167.10 | \$14,593.11 | 100% |

FHWA # 1

FEDERAL PROGRAM CATEGORIES:

National Highway System: 62.5% of Apportioned Federal Funds
Urban/Rural Program: 25.0% of Apportioned Federal Funds
Apportioned Bridge Program: 12.5% of Apportioned Federal Funds
(plus several discretionary programs)

FORMULAS:

National Highway System: $\frac{70\% \text{ Proportional Total Motor Fuel Highway Use}}{30\% \text{ " Total Public Road Mileage}}$
Urban/Rural Program: Proportional Contributions to Highway Trust Fund
Bridge Program: New Level of Service Apportionment Process
(current system used for estimating until the
LOS system is defined)
Density Factor: No Density Factor

GUARANTEED FEDERAL FUNDING OF AT LEAST:

Half Percent: No Provision Made for Half Percent Minimum
Minimum Allocation: No Provision Made for 85% Minimum Allocation
Hold Harmless: Open-ended authorization to make up difference between
the total of states NHP, URP and Bridge apportionments
and the total of their FY 1991 apportionments for
Primary, Interstate 4R, Secondary, Urban, Bridge,
Hazard Elimination, Rail-Highway Crossings, Minimum
Allocation and Interstate 1/2 percent minimum.

\$14.5 Billion Level

FHWA OPTION #1

ALLOCATION FORMULA

TOTAL PROGRAM

National System

| STATE | Total Hwy Fuel Use | Total Center Miles | Total | Urban Rural | Bridges | Total Funding | % of Total |
|----------------|-----------------------|-----------------------|----------|----------------|----------|------------------|---------------|
| ALABAMA | \$120.40 | \$63.53 | \$183.93 | \$71.62 | \$39.17 | \$294.72 | 2.033% |
| ALASKA | \$12.37 | \$8.56 | \$20.93 | \$7.55 | \$4.54 | \$33.02 | 0.228% |
| ARIZONA | \$96.20 | \$49.38 | \$145.58 | \$56.80 | \$4.54 | \$206.92 | 1.427% |
| ARKANSAS | \$78.19 | \$54.17 | \$132.36 | \$52.76 | \$22.69 | \$207.81 | 1.433% |
| CALIFORNIA | \$700.44 | \$114.22 | \$814.66 | \$381.18 | \$58.89 | \$1,254.73 | 8.653% |
| COLORADO | \$82.95 | \$54.21 | \$137.15 | \$44.10 | \$18.39 | \$199.64 | 1.377% |
| CONNECTICUT | \$76.55 | \$13.91 | \$90.46 | \$43.22 | \$80.59 | \$214.27 | 1.478% |
| DELAWARE | \$19.07 | \$3.79 | \$22.85 | \$11.02 | \$5.33 | \$39.21 | 0.270% |
| D.C. | \$9.95 | \$0.77 | \$10.72 | \$5.40 | \$14.36 | \$30.47 | 0.210% |
| FLORIDA | \$319.00 | \$73.49 | \$392.49 | \$174.06 | \$30.04 | \$596.59 | 4.114% |
| GEORGIA | \$208.93 | \$75.45 | \$284.39 | \$133.86 | \$37.01 | \$455.25 | 3.140% |
| HAWAII | \$18.17 | \$2.87 | \$21.04 | \$8.73 | \$5.98 | \$35.74 | 0.247% |
| IDAHO | \$26.26 | \$42.62 | \$68.88 | \$15.87 | \$4.54 | \$89.29 | 0.616% |
| ILLINOIS | \$272.90 | \$95.21 | \$368.11 | \$135.27 | \$53.06 | \$556.45 | 3.838% |
| INDIANA | \$160.35 | \$64.35 | \$224.70 | \$92.40 | \$30.78 | \$347.88 | 2.399% |
| IOWA | \$79.52 | \$79.04 | \$158.56 | \$45.97 | \$33.03 | \$237.55 | 1.638% |
| KANSAS | \$76.04 | \$93.43 | \$169.47 | \$46.71 | \$34.67 | \$250.85 | 1.730% |
| KENTUCKY | \$113.31 | \$49.08 | \$162.39 | \$64.85 | \$36.28 | \$263.52 | 1.817% |
| LOUISIANA | \$114.52 | \$41.05 | \$155.57 | \$67.16 | \$41.81 | \$264.53 | 1.824% |
| MAINE | \$36.14 | \$15.43 | \$51.57 | \$21.48 | \$11.31 | \$84.36 | 0.582% |
| MARYLAND | \$114.50 | \$19.84 | \$134.33 | \$65.76 | \$23.40 | \$223.49 | 1.541% |
| MASSACHUSETTS | \$133.96 | \$23.76 | \$157.71 | \$71.59 | \$93.77 | \$323.07 | 2.228% |
| MICHIGAN | \$231.04 | \$82.84 | \$313.87 | \$117.41 | \$41.46 | \$472.74 | 3.260% |
| MINNESOTA | \$111.33 | \$91.09 | \$202.42 | \$62.22 | \$22.63 | \$287.27 | 1.981% |
| MISSISSIPPI | \$74.22 | \$50.71 | \$124.93 | \$48.97 | \$26.97 | \$200.87 | 1.385% |
| MISSOURI | \$157.20 | \$84.24 | \$241.44 | \$93.44 | \$73.40 | \$408.28 | 2.816% |
| MONTANA | \$25.87 | \$50.22 | \$76.09 | \$17.34 | \$9.45 | \$102.88 | 0.709% |
| NEBRASKA | \$45.74 | \$64.99 | \$110.73 | \$26.54 | \$21.91 | \$159.18 | 1.098% |
| NEVADA | \$34.19 | \$31.50 | \$65.69 | \$19.86 | \$4.54 | \$90.09 | 0.621% |
| NEW HAMPSHIRE | \$27.85 | \$10.34 | \$38.18 | \$14.75 | \$9.80 | \$62.73 | 0.433% |
| NEW JERSEY | \$188.99 | \$24.03 | \$213.02 | \$107.03 | \$80.08 | \$400.13 | 2.760% |
| NEW MEXICO | \$49.00 | \$37.90 | \$86.90 | \$29.76 | \$5.99 | \$122.65 | 0.846% |
| NEW YORK | \$302.34 | \$77.72 | \$380.06 | \$165.43 | \$181.52 | \$727.01 | 5.014% |
| NORTH CAROLINA | \$188.52 | \$65.92 | \$254.43 | \$112.79 | \$37.32 | \$404.54 | 2.790% |
| NORTH DAKOTA | \$20.16 | \$60.65 | \$80.81 | \$12.89 | \$6.68 | \$100.39 | 0.692% |
| OHIO | \$274.65 | \$79.64 | \$354.28 | \$148.23 | \$56.83 | \$559.34 | 3.858% |
| OKLAHOMA | \$96.11 | \$78.28 | \$174.39 | \$61.89 | \$42.06 | \$278.34 | 1.920% |
| OREGON | \$79.26 | \$65.76 | \$145.02 | \$50.05 | \$9.99 | \$205.07 | 1.414% |
| PENNSYLVANIA | \$269.96 | \$81.56 | \$351.52 | \$164.48 | \$160.31 | \$676.31 | 4.664% |
| RHODE ISLAND | \$20.73 | \$4.11 | \$24.84 | \$11.00 | \$4.54 | \$40.37 | 0.278% |
| SOUTH CAROLINA | \$88.77 | \$44.76 | \$133.53 | \$52.84 | \$15.28 | \$201.66 | 1.391% |
| SOUTH DAKOTA | \$22.14 | \$51.59 | \$73.73 | \$13.69 | \$8.98 | \$96.40 | 0.665% |
| TENNESSEE | \$147.69 | \$58.77 | \$206.46 | \$85.13 | \$49.57 | \$341.16 | 2.353% |
| TEXAS | \$480.02 | \$211.10 | \$691.12 | \$268.37 | \$71.36 | \$1,030.85 | 7.109% |
| UTAH | \$44.05 | \$30.17 | \$74.22 | \$26.70 | \$4.54 | \$105.46 | 0.727% |
| VERMONT | \$15.84 | \$9.90 | \$25.74 | \$9.12 | \$10.18 | \$45.05 | 0.311% |
| VIRGINIA | \$171.45 | \$47.00 | \$218.45 | \$98.97 | \$40.02 | \$357.44 | 2.465% |
| WASHINGTON | \$118.76 | \$57.30 | \$176.06 | \$67.48 | \$41.43 | \$284.97 | 1.965% |
| WEST VIRGINIA | \$48.70 | \$24.29 | \$72.99 | \$30.75 | \$52.23 | \$155.96 | 1.076% |
| WISCONSIN | \$119.03 | \$77.03 | \$196.06 | \$72.78 | \$32.25 | \$301.09 | 2.076% |
| WYOMING | \$21.68 | \$28.46 | \$50.14 | \$17.73 | \$4.54 | \$72.41 | 0.499% |
| US TOTAL | \$6,345.00 | \$2,720 | \$9,065 | \$3,625 | \$1,810 | \$14,500 | 100% |

FHWA # 2

FEDERAL PROGRAM CATEGORIES:

National Highway System: 62.5% of Apportioned Federal Funds
 Urban/Rural Program: 25.0% of Apportioned Federal Funds
 Apportioned Bridge Program: 12.5% of Apportioned Federal Funds
 (plus several discretionary programs)

FORMULAS:

National Highway System: 70% Proportional Total Motor Fuel Highway Use
 20% " Total Public Road Mileage
 10% " Land Area
 Urban/Rural Program: Proportional Contributions to Highway Trust Fund
 Bridge Program: New Level of Service Apportionment Process
 (current system used for estimating until the
 LOS system is defined)
 Density Factor: No Density Factor

GUARANTEED FEDERAL FUNDING OF AT LEAST:

Half Percent: No Provision Made for Half Percent Minimum
 Minimum Allocation: No Provision Made for 85% Minimum Allocation
 Hold Harmless: Open-ended authorization to make up difference between
 the total of states NHP, URP and Bridge apportionments
 and the total of their FY 1991 apportionments for
 Primary, Interstate 4R, Secondary, Urban, Bridge,
 Hazard Elimination, Rail-Highway Crossings, Minimum
 Allocation and Interstate 1/2 percent minimum.

\$14.5 Billion Level

FHWA OPTION #2

ALLOCATION FORMULA

TOTAL PROGRAM

National System

| STATE | Total Hwy Fuel Use | Total Center Miles | Total Land Area | Total | Urban Rural | Bridges | Total Funding | % of Total |
|----------------|-----------------------|-----------------------|--------------------|----------|----------------|----------|------------------|---------------|
| ALABAMA | \$120.21 | \$42.28 | \$13.21 | \$175.69 | \$71.62 | \$39.17 | \$286.48 | 1.976% |
| ALASKA | \$12.35 | \$5.70 | \$145.86 | \$163.90 | \$7.55 | \$4.54 | \$175.99 | 1.214% |
| ARIZONA | \$96.05 | \$32.86 | \$29.13 | \$158.04 | \$56.80 | \$4.54 | \$219.38 | 1.513% |
| ARKANSAS | \$78.07 | \$36.05 | \$13.59 | \$127.71 | \$52.76 | \$22.69 | \$203.15 | 1.401% |
| CALIFORNIA | \$699.34 | \$76.01 | \$40.55 | \$815.90 | \$381.18 | \$58.89 | \$1,255.97 | 8.662% |
| COLORADO | \$82.82 | \$36.07 | \$26.60 | \$145.49 | \$44.10 | \$18.39 | \$207.97 | 1.434% |
| CONNECTICUT | \$76.43 | \$9.26 | \$1.28 | \$86.97 | \$43.22 | \$80.59 | \$210.78 | 1.454% |
| DELAWARE | \$19.04 | \$2.52 | \$0.52 | \$22.08 | \$11.02 | \$5.33 | \$38.44 | 0.265% |
| D.C. | \$9.93 | \$0.52 | \$0.02 | \$10.46 | \$5.40 | \$14.36 | \$30.21 | 0.208% |
| FLORIDA | \$318.50 | \$48.90 | \$14.99 | \$382.39 | \$174.06 | \$30.04 | \$586.49 | 4.045% |
| GEORGIA | \$208.60 | \$50.21 | \$15.05 | \$273.87 | \$133.86 | \$37.01 | \$444.73 | 3.067% |
| HAWAII | \$18.14 | \$1.91 | \$1.64 | \$21.69 | \$8.73 | \$5.98 | \$36.40 | 0.251% |
| IDAHO | \$26.22 | \$28.36 | \$21.35 | \$75.93 | \$15.87 | \$4.54 | \$96.34 | 0.664% |
| ILLINOIS | \$272.47 | \$63.36 | \$14.40 | \$350.23 | \$135.27 | \$53.06 | \$538.56 | 3.714% |
| INDIANA | \$160.10 | \$42.82 | \$9.76 | \$212.68 | \$92.40 | \$30.78 | \$335.86 | 2.316% |
| IOWA | \$79.39 | \$52.60 | \$14.38 | \$146.37 | \$45.97 | \$33.03 | \$225.36 | 1.554% |
| KANSAS | \$75.92 | \$62.17 | \$21.02 | \$159.12 | \$46.71 | \$34.67 | \$240.49 | 1.659% |
| KENTUCKY | \$113.14 | \$32.66 | \$10.33 | \$156.12 | \$64.85 | \$36.28 | \$257.24 | 1.774% |
| LOUISIANA | \$114.34 | \$27.32 | \$12.20 | \$153.85 | \$67.16 | \$41.81 | \$262.82 | 1.813% |
| MAINE | \$36.08 | \$10.27 | \$8.50 | \$54.85 | \$21.48 | \$11.31 | \$87.64 | 0.604% |
| MARYLAND | \$114.32 | \$13.20 | \$2.67 | \$130.19 | \$65.76 | \$23.40 | \$219.34 | 1.513% |
| MASSACHUSETTS | \$133.75 | \$15.81 | \$2.12 | \$151.67 | \$71.59 | \$93.77 | \$317.03 | 2.186% |
| MICHIGAN | \$230.67 | \$55.12 | \$14.95 | \$300.75 | \$117.41 | \$41.46 | \$459.61 | 3.170% |
| MINNESOTA | \$111.16 | \$60.62 | \$21.57 | \$193.34 | \$62.22 | \$22.63 | \$278.19 | 1.919% |
| MISSISSIPPI | \$74.11 | \$33.74 | \$12.19 | \$120.04 | \$48.97 | \$26.97 | \$195.97 | 1.352% |
| MISSOURI | \$156.95 | \$56.06 | \$17.81 | \$230.82 | \$93.44 | \$73.40 | \$397.66 | 2.742% |
| MONTANA | \$25.83 | \$33.42 | \$37.57 | \$96.82 | \$17.34 | \$9.45 | \$123.61 | 0.852% |
| NEBRASKA | \$45.67 | \$43.25 | \$19.77 | \$108.68 | \$26.54 | \$21.91 | \$157.13 | 1.084% |
| NEVADA | \$34.14 | \$20.96 | \$28.25 | \$83.35 | \$19.86 | \$4.54 | \$107.75 | 0.743% |
| NEW HAMPSHIRE | \$27.80 | \$6.88 | \$2.37 | \$37.05 | \$14.75 | \$9.80 | \$61.60 | 0.425% |
| NEW JERSEY | \$188.69 | \$15.99 | \$1.99 | \$206.67 | \$107.03 | \$80.08 | \$393.78 | 2.716% |
| NEW MEXICO | \$48.92 | \$25.22 | \$31.07 | \$105.21 | \$29.76 | \$5.99 | \$140.96 | 0.972% |
| NEW YORK | \$301.86 | \$51.72 | \$12.55 | \$366.13 | \$165.43 | \$181.52 | \$713.08 | 4.918% |
| NORTH CAROLINA | \$188.22 | \$43.86 | \$13.46 | \$245.54 | \$112.79 | \$37.32 | \$395.65 | 2.729% |
| NORTH DAKOTA | \$20.13 | \$40.36 | \$18.07 | \$78.55 | \$12.89 | \$6.68 | \$98.13 | 0.677% |
| OHIO | \$274.21 | \$52.99 | \$10.56 | \$337.77 | \$148.23 | \$56.83 | \$542.82 | 3.744% |
| OKLAHOMA | \$95.96 | \$52.09 | \$17.87 | \$165.92 | \$61.89 | \$42.06 | \$269.87 | 1.861% |
| OREGON | \$79.14 | \$43.76 | \$24.80 | \$147.70 | \$50.05 | \$9.99 | \$207.75 | 1.433% |
| PENNSYLVANIA | \$269.53 | \$54.28 | \$11.58 | \$335.38 | \$164.48 | \$160.31 | \$660.18 | 4.553% |
| RHODE ISLAND | \$20.70 | \$2.73 | \$0.31 | \$23.74 | \$11.00 | \$4.54 | \$39.28 | 0.271% |
| SOUTH CAROLINA | \$88.63 | \$29.78 | \$7.95 | \$126.36 | \$52.84 | \$15.28 | \$194.49 | 1.341% |
| SOUTH DAKOTA | \$22.11 | \$34.33 | \$19.70 | \$76.14 | \$13.69 | \$8.98 | \$98.81 | 0.681% |
| TENNESSEE | \$147.46 | \$39.11 | \$10.77 | \$197.34 | \$85.13 | \$49.57 | \$332.04 | 2.290% |
| TEXAS | \$479.26 | \$140.48 | \$68.17 | \$687.91 | \$268.37 | \$71.36 | \$1,027.64 | 7.087% |
| UTAH | \$43.98 | \$20.07 | \$21.69 | \$85.75 | \$26.70 | \$4.54 | \$116.99 | 0.807% |
| VERMONT | \$15.82 | \$6.59 | \$2.46 | \$24.86 | \$9.12 | \$10.18 | \$44.17 | 0.305% |
| VIRGINIA | \$171.18 | \$31.28 | \$10.42 | \$212.87 | \$98.97 | \$40.02 | \$351.86 | 2.427% |
| WASHINGTON | \$118.57 | \$38.13 | \$17.41 | \$174.11 | \$67.48 | \$41.43 | \$283.02 | 1.952% |
| WEST VIRGINIA | \$48.62 | \$16.17 | \$6.19 | \$70.98 | \$30.75 | \$52.23 | \$153.95 | 1.062% |
| WISCONSIN | \$118.84 | \$51.26 | \$14.35 | \$184.45 | \$72.78 | \$32.25 | \$289.48 | 1.996% |
| WYOMING | \$21.65 | \$18.94 | \$24.99 | \$65.58 | \$17.73 | \$4.54 | \$87.85 | 0.606% |
| US TOTAL | \$6,335.00 | \$1,810 | \$920 | \$9,065 | \$3,625 | \$1,810 | \$14,500 | 100% |

CALIFORNIA

FEDERAL PROGRAM CATEGORIES:

Categorical Program: 50% of Federal Funds
Flexible Program: 50% of Federal Funds

FORMULAS:

Categorical Program: 11.0% " Rural Lane Miles
21.9% " Urban lane Miles
11.0% " Rural VMT
21.9% " Urban VMT
33.0% " Diesel Fuel Purchases
1.2% Density Factor (see below for details)
100.0% of Categorical Program Federal Apportionments

Flexible Program: Proportional Contributions to Highway Trust Fund

Density Factor: Increase Categorical Funds By:

| Percent Increase | Persons Per Sq. Mile |
|------------------|----------------------|
| 30% | Fewer than 5 |
| 25% | 5 to 9.9 |
| 20% | 10 to 14.9 |
| 15% | 15 to 19.9 |
| 10% | 20 to 24.9 |
| 0% | 25 or More |

GUARANTEED FEDERAL FUNDING OF NO LESS THAN:

Half Percent: Half Percent of Categorical Program Apportionments

Minimum Allocation: Percent Categorical Apportionments No Less Than 85% of that State's Percent Contributions.

Hold Harmless: FY 1992 and Subsequent Total Federal Funding No Less Than FY 1991 Dollar Amount (less Interstate Completion above half percent, Interstate Transfer, Discretionary and Demonstration Projects) of Federal Highway Funds.

\$14.5 Billion Level

CALIFORNIA

ALLOCATION FORMULA

CATEGORICAL PROGRAM DETAIL

| STATE | Lane Miles | | VMT | | Diesel Fuels | Density Factor | Total Allocation | % of Total |
|----------------|------------|------------|----------|------------|-----------------|-------------------|---------------------|---------------|
| | Rural | Urban | Rural | Urban | | | | |
| ALABAMA | \$18.33 | \$34.43 | \$19.98 | \$24.05 | \$55.92 | | \$152.71 | 2.16% |
| ALASKA | \$2.51 | \$3.46 | \$1.99 | \$2.25 | \$5.03 | \$4.57 | \$19.82 | 0.28% |
| ARIZONA | \$14.87 | \$25.77 | \$13.02 | \$26.43 | \$35.27 | | \$115.36 | 1.63% |
| ARKANSAS | \$17.04 | \$15.49 | \$11.67 | \$8.96 | \$45.37 | | \$98.53 | 1.39% |
| CALIFORNIA | \$23.15 | \$159.78 | \$48.73 | \$244.43 | \$206.97 | | \$683.05 | 9.65% |
| COLORADO | \$16.33 | \$23.52 | \$10.45 | \$21.44 | \$22.22 | | \$93.96 | 1.33% |
| CONNECTICUT | \$2.25 | \$22.06 | \$6.25 | \$25.04 | \$24.13 | | \$79.73 | 1.13% |
| DELAWARE | \$0.97 | \$3.36 | \$2.77 | \$4.49 | \$6.52 | | \$18.11 | 0.26% |
| D.C. | \$0.00 | \$2.50 | \$0.00 | \$4.37 | \$2.71 | | \$9.58 | 0.14% |
| FLORIDA | \$14.47 | \$98.93 | \$28.13 | \$97.30 | \$90.75 | | \$329.59 | 4.66% |
| GEORGIA | \$21.68 | \$42.40 | \$27.98 | \$42.26 | \$97.75 | | \$232.07 | 3.28% |
| HAWAII | \$0.66 | \$3.17 | \$2.22 | \$6.53 | \$2.67 | | \$15.25 | 0.22% |
| IDAHO | \$14.36 | \$4.93 | \$5.34 | \$3.24 | \$11.72 | \$7.92 | \$47.51 | 0.67% |
| ILLINOIS | \$25.88 | \$66.54 | \$23.51 | \$69.09 | \$90.91 | | \$275.93 | 3.90% |
| INDIANA | \$18.61 | \$36.15 | \$27.20 | \$29.01 | \$73.92 | | \$184.89 | 2.61% |
| IOWA | \$25.62 | \$18.39 | \$13.36 | \$10.15 | \$39.35 | | \$106.86 | 1.51% |
| KANSAS | \$30.54 | \$17.98 | \$11.44 | \$11.76 | \$35.14 | | \$106.86 | 1.51% |
| KENTUCKY | \$15.52 | \$15.76 | \$17.72 | \$16.74 | \$59.67 | | \$125.40 | 1.77% |
| LOUISIANA | \$11.53 | \$25.85 | \$16.40 | \$22.45 | \$43.49 | | \$119.72 | 1.69% |
| MAINE | \$4.86 | \$4.77 | \$7.95 | \$3.93 | \$13.54 | | \$35.05 | 0.50% |
| MARYLAND | \$4.15 | \$25.90 | \$12.18 | \$31.73 | \$38.30 | | \$112.26 | 1.59% |
| MASSACHUSETTS | \$3.30 | \$41.46 | \$7.47 | \$45.55 | \$34.15 | | \$131.94 | 1.86% |
| MICHIGAN | \$22.56 | \$57.60 | \$29.35 | \$60.47 | \$61.86 | | \$231.85 | 3.28% |
| MINNESOTA | \$28.60 | \$29.01 | \$16.34 | \$24.79 | \$39.00 | | \$137.75 | 1.95% |
| MISSISSIPPI | \$16.14 | \$14.89 | \$14.16 | \$9.25 | \$37.48 | | \$91.91 | 1.30% |
| MISSOURI | \$25.84 | \$32.04 | \$20.88 | \$30.39 | \$62.96 | | \$172.11 | 2.43% |
| MONTANA | \$17.12 | \$4.41 | \$5.82 | \$2.62 | \$13.63 | \$10.90 | \$54.48 | 0.77% |
| NEBRASKA | \$21.49 | \$10.04 | \$8.09 | \$6.32 | \$23.63 | \$6.96 | \$76.53 | 1.08% |
| NEVADA | \$10.34 | \$6.72 | \$3.71 | \$6.55 | \$13.60 | \$8.18 | \$49.10 | 0.69% |
| NEW HAMPSHIRE | \$3.07 | \$4.77 | \$5.59 | \$4.68 | \$6.83 | | \$24.93 | 0.35% |
| NEW JERSEY | \$3.01 | \$45.91 | \$10.34 | \$61.38 | \$60.20 | | \$180.84 | 2.56% |
| NEW MEXICO | \$12.38 | \$10.02 | \$8.88 | \$7.66 | \$24.07 | \$12.60 | \$75.62 | 1.07% |
| NEW YORK | \$18.26 | \$78.74 | \$28.77 | \$94.35 | \$81.83 | | \$301.95 | 4.27% |
| NORTH CAROLINA | \$18.79 | \$38.07 | \$30.35 | \$33.53 | \$72.08 | | \$192.83 | 2.73% |
| NORTH DAKOTA | \$20.83 | \$3.62 | \$4.03 | \$1.98 | \$10.71 | \$10.29 | \$51.46 | 0.73% |
| OHIO | \$20.62 | \$65.31 | \$33.41 | \$60.26 | \$101.30 | | \$280.90 | 3.97% |
| OKLAHOMA | \$24.61 | \$25.44 | \$15.46 | \$20.77 | \$45.50 | | \$131.78 | 1.86% |
| OREGON | \$20.96 | \$17.70 | \$13.20 | \$14.58 | \$35.56 | | \$102.00 | 1.44% |
| PENNSYLVANIA | \$22.15 | \$57.17 | \$35.04 | \$57.11 | \$109.14 | | \$280.61 | 3.97% |
| RHODE ISLAND | \$0.38 | \$8.88 | \$0.86 | \$6.35 | \$5.12 | | \$21.60 | 0.31% |
| SOUTH CAROLINA | \$13.66 | \$19.56 | \$19.43 | \$14.61 | \$36.50 | | \$103.77 | 1.47% |
| SOUTH DAKOTA | \$17.71 | \$3.62 | \$4.86 | \$1.97 | \$11.11 | \$9.82 | \$49.09 | 0.69% |
| TENNESSEE | \$17.03 | \$31.77 | \$20.46 | \$29.19 | \$67.53 | | \$165.98 | 2.35% |
| TEXAS | \$54.49 | \$174.10 | \$51.25 | \$131.83 | \$156.30 | | \$567.96 | 8.03% |
| UTAH | \$9.38 | \$11.37 | \$4.84 | \$10.51 | \$17.53 | \$5.36 | \$59.00 | 0.83% |
| VERMONT | \$3.28 | \$1.93 | \$4.08 | \$1.64 | \$5.35 | | \$16.27 | 0.23% |
| VIRGINIA | \$13.32 | \$31.52 | \$25.36 | \$39.61 | \$66.87 | | \$176.69 | 2.50% |
| WASHINGTON | \$16.14 | \$33.97 | \$14.59 | \$34.03 | \$39.93 | | \$138.65 | 1.96% |
| WEST VIRGINIA | \$7.88 | \$6.04 | \$9.54 | \$4.99 | \$21.83 | | \$50.27 | 0.71% |
| WISCONSIN | \$23.71 | \$29.31 | \$21.39 | \$25.71 | \$49.26 | | \$149.38 | 2.11% |
| WYOMING | \$9.63 | \$3.90 | \$4.13 | \$1.70 | \$17.79 | \$9.29 | \$46.44 | 0.66% |
| US TOTAL | \$780.00 | \$1,550.00 | \$780.00 | \$1,550.00 | \$2,330.00 | \$85.89 | \$7,075.89 | 100% |

\$14.5 Billion Level

| CALIFORNIA | | | | ALLOCATION FORMULA | | SUMMARY FUNDING | | |
|----------------|---------------------|----------|--------|--------------------|------------------|-----------------|---------------|------------|
| STATE | Categorical Program | | | Total | Flexible Program | Hold Harmless | Total Funding | % of Total |
| | Formula | Half % | 85% MA | | | | | |
| ALABAMA | \$152.71 | | | \$152.71 | \$142.26 | | \$294.96 | 2.030% |
| ALASKA | \$19.82 | \$15.18 | | \$35.00 | \$14.99 | \$103.34 | \$153.34 | 1.055% |
| ARIZONA | \$115.36 | | | \$115.36 | \$112.82 | | \$228.18 | 1.570% |
| ARKANSAS | \$98.53 | | | \$98.53 | \$104.78 | | \$203.31 | 1.399% |
| CALIFORNIA | \$683.05 | | | \$683.05 | \$757.11 | | \$1,440.16 | 9.911% |
| COLORADO | \$93.96 | | | \$93.96 | \$87.59 | | \$181.55 | 1.249% |
| CONNECTICUT | \$79.73 | | | \$79.73 | \$85.85 | | \$165.58 | 1.139% |
| DELAWARE | \$18.11 | \$16.89 | | \$35.00 | \$21.89 | | \$56.89 | 0.392% |
| D.C. | \$9.58 | \$25.42 | | \$35.00 | \$10.72 | \$8.63 | \$54.34 | 0.374% |
| FLORIDA | \$329.59 | | | \$329.59 | \$345.72 | | \$675.31 | 4.647% |
| GEORGIA | \$232.07 | | | \$232.07 | \$265.87 | | \$497.94 | 3.427% |
| HAWAII | \$15.25 | \$19.75 | | \$35.00 | \$17.34 | | \$52.34 | 0.360% |
| IDAHO | \$47.51 | | | \$47.51 | \$31.52 | | \$79.03 | 0.544% |
| ILLINOIS | \$275.93 | | | \$275.93 | \$268.68 | | \$544.60 | 3.748% |
| INDIANA | \$184.89 | | | \$184.89 | \$183.53 | | \$368.42 | 2.535% |
| IOA | \$106.86 | | | \$106.86 | \$91.30 | | \$198.16 | 1.364% |
| KENTUCKY | \$106.86 | | | \$106.86 | \$92.77 | | \$199.63 | 1.374% |
| LOUISIANA | \$125.40 | | | \$125.40 | \$128.80 | | \$254.19 | 1.749% |
| LOUISIANA | \$119.72 | | | \$119.72 | \$133.40 | | \$253.12 | 1.742% |
| MAINE | \$35.05 | | \$0.21 | \$35.26 | \$42.67 | | \$77.93 | 0.536% |
| MARYLAND | \$112.26 | | | \$112.26 | \$130.61 | | \$242.86 | 1.671% |
| MASSACHUSETTS | \$131.94 | | | \$131.94 | \$142.20 | | \$274.13 | 1.887% |
| MICHIGAN | \$231.85 | | | \$231.85 | \$233.19 | | \$465.04 | 3.200% |
| MINNESOTA | \$137.75 | | | \$137.75 | \$123.59 | | \$261.33 | 1.799% |
| MISSISSIPPI | \$91.91 | | | \$91.91 | \$97.26 | | \$189.17 | 1.302% |
| MISSOURI | \$172.11 | | | \$172.11 | \$185.59 | | \$357.71 | 2.462% |
| MONTANA | \$54.48 | | | \$54.48 | \$34.45 | \$18.20 | \$107.14 | 0.737% |
| NEBRASKA | \$76.53 | | | \$76.53 | \$52.72 | | \$129.25 | 0.889% |
| NEVADA | \$49.10 | | | \$49.10 | \$39.45 | | \$88.55 | 0.609% |
| NEW HAMPSHIRE | \$24.93 | \$10.07 | | \$35.00 | \$29.29 | | \$64.29 | 0.442% |
| NEW JERSEY | \$180.84 | | | \$180.84 | \$212.58 | | \$393.41 | 2.707% |
| NEW MEXICO | \$75.62 | | | \$75.62 | \$59.10 | | \$134.72 | 0.927% |
| NEW YORK | \$301.95 | | | \$301.95 | \$328.58 | | \$630.53 | 4.339% |
| NORTH CAROLINA | \$192.83 | | | \$192.83 | \$224.02 | | \$416.85 | 2.869% |
| NORTH DAKOTA | \$51.46 | | | \$51.46 | \$25.61 | | \$77.07 | 0.530% |
| OHIO | \$280.90 | | | \$280.90 | \$294.42 | | \$575.31 | 3.959% |
| OKLAHOMA | \$131.78 | | | \$131.78 | \$122.92 | | \$254.70 | 1.753% |
| OREGON | \$102.00 | | | \$102.00 | \$99.41 | | \$201.41 | 1.386% |
| PENNSYLVANIA | \$280.61 | | | \$280.61 | \$326.69 | | \$607.30 | 4.179% |
| RHODE ISLAND | \$21.60 | \$13.40 | | \$35.00 | \$21.85 | | \$56.85 | 0.391% |
| SOUTH CAROLINA | \$103.77 | | | \$103.77 | \$104.96 | | \$208.72 | 1.436% |
| SOUTH DAKOTA | \$49.09 | | | \$49.09 | \$27.20 | \$3.14 | \$79.43 | 0.547% |
| TENNESSEE | \$165.98 | | | \$165.98 | \$169.09 | | \$335.07 | 2.306% |
| TEXAS | \$567.96 | | | \$567.96 | \$533.05 | | \$1,101.01 | 7.577% |
| UTAH | \$59.00 | | | \$59.00 | \$53.03 | | \$112.02 | 0.771% |
| VERMONT | \$16.27 | \$18.73 | | \$35.00 | \$18.12 | \$1.53 | \$54.65 | 0.376% |
| VIRGINIA | \$176.69 | | | \$176.69 | \$196.57 | | \$373.26 | 2.569% |
| WASHINGTON | \$138.65 | | | \$138.65 | \$134.03 | | \$272.69 | 1.877% |
| WEST VIRGINIA | \$50.27 | | \$0.19 | \$50.46 | \$61.07 | \$0.01 | \$111.54 | 0.768% |
| WISCONSIN | \$149.38 | | | \$149.38 | \$144.57 | | \$293.95 | 2.023% |
| WYOMING | \$46.44 | | | \$46.44 | \$35.22 | | \$81.66 | 0.562% |
| US TOTAL | \$7,075.89 | \$119.43 | \$0.40 | \$7,195.73 | \$7,200.00 | \$134.86 | \$14,530.59 | 100% |

CRESCENT COALITION

FEDERAL PROGRAM CATEGORIES:

Categorical Program: 50% of Federal Funds

Flexible Program: 50% of Federal Funds

FORMULAS:

Categorical Program: 11.1% Proportional Rural Lane Miles
 22.1% " Urban lane Miles
 11.1% " Rural VMT
 22.1% " Urban VMT
 33.6% " Diesel Fuel Purchases
 100.0% of Categorical Program Federal Apportionments

Flexible Program: Proportional Contributions to Highway Trust Fund

Density Factor: No Density Factor

GUARANTEED FEDERAL FUNDING OF NO LESS THAN:

Half Percent: Half Percent of Categorical Program Apportionments

Minimum Allocation: Percent Categorical Apportionments No Less Than 85% of that State's Percent Contributions.

Hold Harmless: FY 1992 and Subsequent Total Federal Funding No Less Than FY 1991 Dollar Amount (less Interstate Completion above half percent, Interstate Transfer, Discretionary and Demonstration Projects) of Federal Highway Funds.

\$14.5 Billion Level

CRESCENT COALITION

ALLOCATION FORMULA

CATEGORICAL PROGRAM DETAIL

| STATE | Lane Miles | | VMT | | Diesel Fuels | Total Allocation | % of Total |
|----------------|------------|------------|----------|------------|-----------------|---------------------|---------------|
| | Rural | Urban | Rural | Urban | | | |
| ALABAMA | \$18.33 | \$34.43 | \$19.98 | \$24.05 | \$56.16 | \$152.95 | 2.18% |
| ALASKA | \$2.51 | \$3.46 | \$1.99 | \$2.25 | \$5.06 | \$15.27 | 0.22% |
| ARIZONA | \$14.87 | \$25.77 | \$13.02 | \$26.43 | \$35.43 | \$115.51 | 1.65% |
| ARKANSAS | \$17.04 | \$15.49 | \$11.67 | \$8.96 | \$45.56 | \$98.73 | 1.41% |
| CALIFORNIA | \$23.15 | \$159.78 | \$48.73 | \$244.43 | \$207.86 | \$683.94 | 9.77% |
| COLORADO | \$16.33 | \$23.52 | \$10.45 | \$21.44 | \$22.31 | \$94.05 | 1.34% |
| CONNECTICUT | \$2.25 | \$22.06 | \$6.25 | \$25.04 | \$24.23 | \$79.83 | 1.14% |
| DELAWARE | \$0.97 | \$3.36 | \$2.77 | \$4.49 | \$6.54 | \$18.14 | 0.26% |
| D.C. | \$0.00 | \$2.50 | \$0.00 | \$4.37 | \$2.72 | \$9.59 | 0.14% |
| FLORIDA | \$14.47 | \$98.93 | \$28.13 | \$97.30 | \$91.14 | \$329.97 | 4.71% |
| GEORGIA | \$21.68 | \$42.40 | \$27.98 | \$42.26 | \$98.17 | \$232.49 | 3.32% |
| HAWAII | \$0.66 | \$3.17 | \$2.22 | \$6.53 | \$2.68 | \$15.26 | 0.22% |
| IDAHO | \$14.36 | \$4.93 | \$5.34 | \$3.24 | \$11.77 | \$39.64 | 0.57% |
| ILLINOIS | \$25.88 | \$66.54 | \$23.51 | \$69.09 | \$91.30 | \$276.32 | 3.95% |
| INDIANA | \$18.61 | \$36.15 | \$27.20 | \$29.01 | \$74.24 | \$185.21 | 2.65% |
| IOWA | \$25.62 | \$18.39 | \$13.36 | \$10.15 | \$39.52 | \$107.03 | 1.53% |
| KANSAS | \$30.54 | \$17.98 | \$11.44 | \$11.76 | \$35.29 | \$107.01 | 1.53% |
| KENTUCKY | \$15.52 | \$15.76 | \$17.72 | \$16.74 | \$59.93 | \$125.65 | 1.80% |
| LOUISIANA | \$11.53 | \$25.85 | \$16.40 | \$22.45 | \$43.68 | \$119.91 | 1.71% |
| MAINE | \$4.86 | \$4.77 | \$7.95 | \$3.93 | \$13.60 | \$35.11 | 0.50% |
| MARYLAND | \$4.15 | \$25.90 | \$12.18 | \$31.73 | \$38.46 | \$112.42 | 1.61% |
| MASSACHUSETTS | \$3.30 | \$41.46 | \$7.47 | \$45.55 | \$34.29 | \$132.08 | 1.89% |
| MICHIGAN | \$22.56 | \$57.60 | \$29.35 | \$60.47 | \$62.12 | \$232.11 | 3.32% |
| MINNESOTA | \$28.60 | \$29.01 | \$16.34 | \$24.79 | \$39.17 | \$137.91 | 1.97% |
| MISSISSIPPI | \$16.14 | \$14.89 | \$14.16 | \$9.25 | \$37.64 | \$92.07 | 1.32% |
| MISSOURI | \$25.84 | \$32.04 | \$20.88 | \$30.39 | \$63.23 | \$172.38 | 2.46% |
| MONTANA | \$17.12 | \$4.41 | \$5.82 | \$2.62 | \$13.69 | \$43.65 | 0.62% |
| NEBRASKA | \$21.49 | \$10.04 | \$8.09 | \$6.32 | \$23.74 | \$69.67 | 1.00% |
| NEVADA | \$10.34 | \$6.72 | \$3.71 | \$6.55 | \$13.66 | \$40.97 | 0.59% |
| NEW HAMPSHIRE | \$3.07 | \$4.77 | \$5.59 | \$4.68 | \$6.86 | \$24.96 | 0.36% |
| NEW JERSEY | \$3.01 | \$45.91 | \$10.34 | \$61.38 | \$60.46 | \$181.09 | 2.59% |
| NEW MEXICO | \$12.38 | \$10.02 | \$8.88 | \$7.66 | \$24.18 | \$63.12 | 0.90% |
| NEW YORK | \$18.26 | \$78.74 | \$28.77 | \$94.35 | \$82.18 | \$302.30 | 4.32% |
| NORTH CAROLINA | \$18.79 | \$38.07 | \$30.35 | \$33.53 | \$72.39 | \$193.14 | 2.76% |
| NORTH DAKOTA | \$20.83 | \$3.62 | \$4.03 | \$1.98 | \$10.75 | \$41.21 | 0.59% |
| OHIO | \$20.62 | \$65.31 | \$33.41 | \$60.26 | \$101.73 | \$281.33 | 4.02% |
| OKLAHOMA | \$24.61 | \$25.44 | \$15.46 | \$20.77 | \$45.70 | \$131.97 | 1.89% |
| OREGON | \$20.96 | \$17.70 | \$13.20 | \$14.58 | \$35.71 | \$102.15 | 1.46% |
| PENNSYLVANIA | \$22.15 | \$57.17 | \$35.04 | \$57.11 | \$109.61 | \$281.08 | 4.02% |
| RHODE ISLAND | \$0.38 | \$8.88 | \$0.86 | \$6.35 | \$5.15 | \$21.62 | 0.31% |
| SOUTH CAROLINA | \$13.66 | \$19.56 | \$19.43 | \$14.61 | \$36.65 | \$103.92 | 1.48% |
| SOUTH DAKOTA | \$17.71 | \$3.62 | \$4.86 | \$1.97 | \$11.15 | \$39.32 | 0.56% |
| TENNESSEE | \$17.03 | \$31.77 | \$20.46 | \$29.19 | \$67.82 | \$166.27 | 2.38% |
| TEXAS | \$54.49 | \$174.10 | \$51.25 | \$131.83 | \$156.97 | \$568.64 | 8.12% |
| UTAH | \$9.38 | \$11.37 | \$4.84 | \$10.51 | \$17.61 | \$53.71 | 0.77% |
| VERMONT | \$3.28 | \$1.93 | \$4.08 | \$1.64 | \$5.37 | \$16.30 | 0.23% |
| VIRGINIA | \$13.32 | \$31.52 | \$25.36 | \$39.61 | \$67.16 | \$176.98 | 2.53% |
| WASHINGTON | \$16.14 | \$33.97 | \$14.59 | \$34.03 | \$40.10 | \$138.82 | 1.98% |
| WEST VIRGINIA | \$7.88 | \$6.04 | \$9.54 | \$4.99 | \$21.93 | \$50.37 | 0.72% |
| WISCONSIN | \$23.71 | \$29.31 | \$21.39 | \$25.71 | \$49.47 | \$149.59 | 2.14% |
| WYOMING | \$9.63 | \$3.90 | \$4.13 | \$1.70 | \$17.87 | \$37.23 | 0.53% |
| US TOTAL | \$780.00 | \$1,550.00 | \$780.00 | \$1,550.00 | \$2,340.00 | \$7,000.00 | 100.00% |

\$14.5 Billion Level

CRESCENT COALITION

ALLOCATION FORMULA

SUMMARY FUNDING

| STATE | Categorical Program | | | | Flexible Program | Hold Harmless | Total Funding | % of Total |
|----------------|---------------------|----------|--------|------------|------------------|---------------|---------------|------------|
| | Formula | Half % | 85% MA | Total | | | | |
| ALABAMA | \$152.95 | | | \$152.95 | \$141.27 | | \$294.21 | 2.037% |
| ALASKA | \$15.27 | \$19.73 | | \$35.00 | \$14.89 | \$103.45 | \$153.34 | 1.061% |
| ARIZONA | \$115.51 | | | \$115.51 | \$112.03 | | \$227.55 | 1.575% |
| ARKANSAS | \$98.73 | | | \$98.73 | \$104.06 | | \$202.78 | 1.404% |
| CALIFORNIA | \$683.94 | | | \$683.94 | \$751.85 | | \$1,435.79 | 9.938% |
| COLORADO | \$94.05 | | | \$94.05 | \$86.98 | | \$181.04 | 1.253% |
| CONNECTICUT | \$79.83 | | | \$79.83 | \$85.25 | | \$165.08 | 1.143% |
| DELAWARE | \$18.14 | \$16.86 | | \$35.00 | \$21.74 | | \$56.74 | 0.393% |
| D.C. | \$9.59 | \$25.41 | | \$35.00 | \$10.64 | \$8.70 | \$54.34 | 0.376% |
| FLORIDA | \$329.97 | | | \$329.97 | \$343.32 | | \$673.29 | 4.660% |
| GEORGIA | \$232.49 | | | \$232.49 | \$264.02 | | \$496.51 | 3.437% |
| HAWAII | \$15.26 | \$19.74 | | \$35.00 | \$17.22 | | \$52.22 | 0.361% |
| IDAHO | \$39.64 | | | \$39.64 | \$31.30 | \$2.05 | \$72.99 | 0.505% |
| ILLINOIS | \$276.32 | | | \$276.32 | \$266.81 | | \$543.13 | 3.759% |
| INDIANA | \$185.21 | | | \$185.21 | \$182.25 | | \$367.46 | 2.544% |
| IOWA | \$107.03 | | | \$107.03 | \$90.67 | | \$197.69 | 1.368% |
| KANSAS | \$107.01 | | | \$107.01 | \$92.12 | | \$199.14 | 1.378% |
| KENTUCKY | \$125.65 | | | \$125.65 | \$127.90 | | \$253.55 | 1.755% |
| LOUISIANA | \$119.91 | | | \$119.91 | \$132.47 | | \$252.38 | 1.747% |
| MAINE | \$35.11 | | | \$35.11 | \$42.37 | | \$77.48 | 0.536% |
| MARYLAND | \$112.42 | | | \$112.42 | \$129.70 | | \$242.12 | 1.676% |
| MASSACHUSETTS | \$132.08 | | | \$132.08 | \$141.21 | | \$273.29 | 1.892% |
| MICHIGAN | \$232.11 | | | \$232.11 | \$231.57 | | \$463.69 | 3.210% |
| MINNESOTA | \$137.91 | | | \$137.91 | \$122.73 | | \$260.64 | 1.804% |
| MISSISSIPPI | \$92.07 | | | \$92.07 | \$96.58 | | \$188.66 | 1.306% |
| MISSOURI | \$172.38 | | | \$172.38 | \$184.30 | | \$356.69 | 2.469% |
| MONTANA | \$43.65 | | | \$43.65 | \$34.21 | \$29.28 | \$107.14 | 0.742% |
| NEBRASKA | \$69.67 | | | \$69.67 | \$52.35 | | \$122.03 | 0.845% |
| NEVADA | \$40.97 | | | \$40.97 | \$39.18 | | \$80.15 | 0.555% |
| NEW HAMPSHIRE | \$24.96 | \$10.04 | | \$35.00 | \$29.09 | | \$64.09 | 0.444% |
| NEW JERSEY | \$181.09 | | | \$181.09 | \$211.10 | | \$392.20 | 2.715% |
| NEW MEXICO | \$63.12 | | | \$63.12 | \$58.69 | | \$121.81 | 0.843% |
| NEW YORK | \$302.30 | | | \$302.30 | \$326.30 | | \$628.60 | 4.351% |
| NORTH CAROLINA | \$193.14 | | | \$193.14 | \$222.47 | | \$415.60 | 2.877% |
| NORTH DAKOTA | \$41.21 | | | \$41.21 | \$25.43 | \$5.67 | \$72.32 | 0.501% |
| OHIO | \$281.33 | | | \$281.33 | \$292.37 | | \$573.70 | 3.971% |
| OKLAHOMA | \$131.97 | | | \$131.97 | \$122.07 | | \$254.04 | 1.758% |
| OREGON | \$102.15 | | | \$102.15 | \$98.72 | | \$200.88 | 1.390% |
| PENNSYLVANIA | \$281.08 | | | \$281.08 | \$324.42 | | \$605.50 | 4.191% |
| RHODE ISLAND | \$21.62 | \$13.38 | | \$35.00 | \$21.69 | | \$56.69 | 0.392% |
| SOUTH CAROLINA | \$103.92 | | | \$103.92 | \$104.23 | | \$208.15 | 1.441% |
| SOUTH DAKOTA | \$39.32 | | | \$39.32 | \$27.01 | \$13.10 | \$79.43 | 0.550% |
| TENNESSEE | \$166.27 | | | \$166.27 | \$167.92 | | \$334.19 | 2.313% |
| TEXAS | \$568.64 | | | \$568.64 | \$529.34 | | \$1,097.98 | 7.600% |
| UTAH | \$53.71 | | | \$53.71 | \$52.66 | | \$106.37 | 0.736% |
| VERMONT | \$16.30 | \$18.70 | | \$35.00 | \$17.99 | \$1.66 | \$54.65 | 0.378% |
| VIRGINIA | \$176.98 | | | \$176.98 | \$195.21 | | \$372.19 | 2.576% |
| WASHINGTON | \$138.82 | | | \$138.82 | \$133.10 | | \$271.93 | 1.882% |
| WEST VIRGINIA | \$50.37 | | | \$50.37 | \$60.64 | \$0.53 | \$111.54 | 0.772% |
| WISCONSIN | \$149.59 | | | \$149.59 | \$143.56 | | \$293.15 | 2.029% |
| WYOMING | \$37.23 | | | \$37.23 | \$34.98 | \$8.64 | \$80.85 | 0.560% |
| US TOTAL | \$7,000.00 | \$123.86 | \$0.00 | \$7,123.86 | \$7,150.00 | \$173.09 | \$14,446.95 | 100% |

DAKOTAS

FEDERAL PROGRAM CATEGORIES:

| | |
|---------------------------------------|------------------------------------|
| Interstate 4R: | 35.0% of Apportioned Federal Funds |
| Primary: | 27.5% of Apportioned Federal Funds |
| Secondary: | 6.5% of Apportioned Federal Funds |
| Urban: | 8.5% of Apportioned Federal Funds |
| Bridge: | 17.5% of Apportioned Federal Funds |
| Safety Construction: | 5.0% of Apportioned Federal Funds |
| (plus several discretionary programs) | |

FORMULAS:

| | |
|-------------------|--|
| Interstate 4R: | Continue Current Formula |
| Other Categories: | Generally Continue Current Formulas (Consider adjusting the formula factors to provide a more contemporary measure of today's highway needs) |

GUARANTEED FEDERAL FUNDING OF NO LESS THAN:

| | |
|---------------------|--|
| Half Percent: | Half Percent for Each Program |
| Minimum Allocation: | Percent of Total Apportionments and Allocations No Less than 85% of that State's Percent Contributions. |
| Hold Harmless: | No Provision for Hold Harmless |

\$14.5 Billion Level

| DAKOTAS | | ALLOCATION FORMULA | | TOTAL PROGRAM |
|----------------|---------------------------|--------------------|----------------------|------------------|
| STATE | Interstate 4-R Formula | Primary Formula | Secondary Formula | Urban Formula |
| ALABAMA | \$93.13 | \$69.79 | \$18.91 | \$15.59 |
| ALASKA | \$40.93 | \$126.60 | \$50.53 | \$6.02 |
| ARIZONA | \$107.98 | \$52.74 | \$15.26 | \$15.56 |
| ARKANSAS | \$52.10 | \$49.02 | \$16.95 | \$7.35 |
| CALIFORNIA | \$474.77 | \$283.29 | \$38.21 | \$152.51 |
| COLORADO | \$94.57 | \$61.29 | \$18.49 | \$16.14 |
| CONNECTICUT | \$63.32 | \$42.79 | \$6.13 | \$17.28 |
| DELAWARE | \$24.62 | \$19.18 | \$4.58 | \$6.02 |
| D.C. | \$24.62 | \$19.18 | \$0.00 | \$6.02 |
| FLORIDA | \$175.50 | \$128.84 | \$23.75 | \$57.46 |
| GEORGIA | \$174.19 | \$94.20 | \$24.80 | \$22.92 |
| HAWAII | \$24.62 | \$19.18 | \$4.58 | \$6.02 |
| IDAHO | \$44.51 | \$30.82 | \$11.24 | \$6.02 |
| ILLINOIS | \$176.01 | \$152.15 | \$26.03 | \$66.09 |
| INDIANA | \$109.55 | \$89.07 | \$21.55 | \$23.94 |
| IOWA | \$70.57 | \$58.26 | \$19.28 | \$10.96 |
| KANSAS | \$71.65 | \$54.76 | \$18.15 | \$10.24 |
| KENTUCKY | \$85.89 | \$66.96 | \$18.99 | \$12.25 |
| LOUISIANA | \$85.91 | \$65.79 | \$15.35 | \$19.53 |
| MAINE | \$24.62 | \$24.46 | \$7.96 | \$6.02 |
| MARYLAND | \$75.43 | \$57.57 | \$9.08 | \$23.69 |
| MASSACHUSETTS | \$62.37 | \$75.58 | \$9.36 | \$33.58 |
| MICHIGAN | \$162.84 | \$139.99 | \$27.23 | \$45.41 |
| MINNESOTA | \$92.25 | \$73.65 | \$22.41 | \$18.21 |
| MISSISSIPPI | \$61.30 | \$53.80 | \$16.76 | \$7.68 |
| MISSOURI | \$138.65 | \$87.51 | \$24.43 | \$22.54 |
| MONTANA | \$80.06 | \$44.59 | \$17.00 | \$6.02 |
| NEBRASKA | \$41.65 | \$41.91 | \$14.36 | \$6.63 |
| NEVADA | \$43.53 | \$31.90 | \$11.07 | \$6.02 |
| NEW HAMPSHIRE | \$24.62 | \$19.18 | \$4.58 | \$6.02 |
| NEW JERSEY | \$62.16 | \$90.60 | \$8.38 | \$46.26 |
| NEW MEXICO | \$81.97 | \$43.45 | \$15.10 | \$6.33 |
| NEW YORK | \$171.97 | \$228.35 | \$27.62 | \$104.23 |
| NORTH CAROLINA | \$89.86 | \$109.67 | \$28.93 | \$18.66 |
| NORTH DAKOTA | \$39.29 | \$29.17 | \$10.94 | \$6.02 |
| OHIO | \$197.29 | \$158.98 | \$28.71 | \$55.01 |
| OKLAHOMA | \$69.00 | \$57.62 | \$18.07 | \$13.40 |
| OREGON | \$73.96 | \$49.76 | \$15.45 | \$11.98 |
| PENNSYLVANIA | \$127.08 | \$182.68 | \$34.73 | \$56.52 |
| RHODE ISLAND | \$24.62 | \$19.18 | \$4.58 | \$6.02 |
| SOUTH CAROLINA | \$80.09 | \$55.84 | \$14.57 | \$11.06 |
| SOUTH DAKOTA | \$48.69 | \$31.30 | \$11.89 | \$6.02 |
| TENNESSEE | \$123.32 | \$80.38 | \$21.44 | \$18.83 |
| TEXAS | \$394.34 | \$224.34 | \$57.75 | \$77.79 |
| UTAH | \$77.02 | \$33.54 | \$10.26 | \$8.47 |
| VERMONT | \$24.88 | \$19.18 | \$4.58 | \$6.02 |
| VIRGINIA | \$136.69 | \$84.51 | \$20.32 | \$24.40 |
| WASHINGTON | \$109.32 | \$67.15 | \$15.92 | \$20.87 |
| WEST VIRGINIA | \$36.70 | \$40.17 | \$11.61 | \$6.02 |
| WISCONSIN | \$66.20 | \$80.82 | \$21.04 | \$20.28 |
| WYOMING | \$63.74 | \$29.25 | \$11.06 | \$6.02 |
| US TOTAL | \$4,900.00 | \$3,850.00 | \$910.00 | \$1,190.00 |

DAKOTAS (continued)

| STATE | Bridge Formula | Safety Construction Formula | 85% MA | Total Funding | % of Total |
|----------------|-------------------|-----------------------------------|----------|------------------|---------------|
| ALABAMA | \$53.02 | \$13.49 | | \$263.93 | 1.829% |
| ALASKA | \$6.14 | \$6.20 | | \$236.42 | 1.638% |
| ARIZONA | \$6.14 | \$8.53 | | \$206.22 | 1.429% |
| ARKANSAS | \$30.71 | \$9.48 | \$7.57 | \$173.18 | 1.200% |
| CALIFORNIA | \$79.71 | \$55.77 | \$167.05 | \$1,251.33 | 8.670% |
| COLORADO | \$24.89 | \$10.11 | | \$225.50 | 1.562% |
| CONNECTICUT | \$109.08 | \$6.80 | | \$245.41 | 1.700% |
| DELAWARE | \$7.22 | \$3.11 | | \$64.74 | 0.449% |
| D.C. | \$19.43 | \$2.66 | | \$71.91 | 0.498% |
| FLORIDA | \$40.66 | \$24.85 | \$120.35 | \$571.40 | 3.959% |
| GEORGIA | \$50.09 | \$18.61 | \$54.60 | \$439.42 | 3.045% |
| HAWAII | \$8.09 | \$2.94 | | \$65.44 | 0.453% |
| IDAHO | \$6.14 | \$5.40 | | \$104.14 | 0.722% |
| ILLINOIS | \$71.83 | \$33.34 | | \$525.46 | 3.641% |
| INDIANA | \$41.66 | \$18.71 | | \$304.47 | 2.110% |
| IOWA | \$44.71 | \$13.58 | | \$217.36 | 1.506% |
| KANSAS | \$46.93 | \$15.04 | | \$216.77 | 1.502% |
| KENTUCKY | \$49.11 | \$11.51 | | \$244.70 | 1.695% |
| LOUISIANA | \$56.59 | \$12.94 | | \$256.11 | 1.774% |
| MAINE | \$15.31 | \$3.81 | | \$82.18 | 0.569% |
| MARYLAND | \$31.67 | \$9.39 | \$9.02 | \$215.86 | 1.496% |
| MASSACHUSETTS | \$126.93 | \$12.61 | | \$320.42 | 2.220% |
| MICHIGAN | \$56.12 | \$25.55 | | \$457.13 | 3.167% |
| MINNESOTA | \$30.63 | \$16.19 | | \$253.34 | 1.755% |
| MISSISSIPPI | \$36.50 | \$9.09 | | \$185.14 | 1.283% |
| MISSOURI | \$99.35 | \$17.02 | | \$389.51 | 2.699% |
| MONTANA | \$12.79 | \$5.79 | | \$166.26 | 1.152% |
| NEBRASKA | \$29.65 | \$9.22 | | \$143.43 | 0.994% |
| NEVADA | \$6.14 | \$3.73 | | \$102.40 | 0.709% |
| NEW HAMPSHIRE | \$13.27 | \$3.29 | | \$70.97 | 0.492% |
| NEW JERSEY | \$108.40 | \$16.09 | \$19.46 | \$351.35 | 2.434% |
| NEW MEXICO | \$8.11 | \$5.39 | | \$160.35 | 1.111% |
| NEW YORK | \$245.71 | \$38.61 | | \$816.48 | 5.657% |
| NORTH CAROLINA | \$50.52 | \$17.69 | \$54.92 | \$370.26 | 2.565% |
| NORTH DAKOTA | \$9.04 | \$7.89 | | \$102.36 | 0.709% |
| OHIO | \$76.92 | \$29.87 | | \$546.78 | 3.788% |
| OKLAHOMA | \$56.94 | \$12.89 | | \$227.93 | 1.579% |
| OREGON | \$13.52 | \$10.04 | | \$174.71 | 1.211% |
| PENNSYLVANIA | \$217.00 | \$30.04 | | \$648.04 | 4.490% |
| RHODE ISLAND | \$6.14 | \$3.03 | | \$63.58 | 0.440% |
| SOUTH CAROLINA | \$20.69 | \$10.58 | | \$192.84 | 1.336% |
| SOUTH DAKOTA | \$12.15 | \$5.76 | | \$115.81 | 0.802% |
| TENNESSEE | \$67.10 | \$14.34 | | \$325.41 | 2.255% |
| TEXAS | \$96.59 | \$46.83 | | \$897.64 | 6.219% |
| UTAH | \$6.14 | \$5.26 | | \$140.69 | 0.975% |
| VERMONT | \$13.78 | \$3.30 | | \$71.74 | 0.497% |
| VIRGINIA | \$54.17 | \$14.12 | | \$334.21 | 2.316% |
| WASHINGTON | \$56.08 | \$12.77 | | \$282.11 | 1.955% |
| WEST VIRGINIA | \$70.70 | \$6.62 | | \$171.82 | 1.190% |
| WISCONSIN | \$43.66 | \$16.34 | | \$248.33 | 1.721% |
| WYOMING | \$6.14 | \$3.77 | | \$119.98 | 0.831% |
| US TOTAL | \$2,450.00 | \$700.00 | \$432.97 | \$14,432.97 | 100% |

MAINE # 2

FEDERAL PROGRAM CATEGORIES:

Categorical Program: 50% of Federal Funds

Flexible Program: 50% of Federal Funds

FORMULAS:

| | | | |
|----------------------|-------|--------------|-----------------------|
| Categorical Program: | 16.7% | Proportional | Bridge Cost Share |
| | 13.9% | " | Rural Lane Miles |
| | 19.4% | " | Urban lane Miles |
| | 13.9% | " | Rural VMT |
| | 19.4% | " | Urban VMT |
| | 16.7% | " | Diesel Fuel Purchases |

100.0% of Categorical Program Federal Apportionments

Flexible Program: Proportional Contributions to Highway Trust Fund

Density Factor: No Density Factor

GUARANTEED FEDERAL FUNDING OF NO LESS THAN:

Half Percent: Half Percent of Categorical Program Apportionments

Minimum Allocation: Percent Categorical Apportionments No Less Than 85% of that State's Percent Contributions.

Hold Harmless: FY 1992 and Subsequent Total Federal Funding No Less Than FY 1991 Dollar Amount (less Interstate Completion above half percent, Interstate Transfer, Discretionary and Demonstration Projects) of Federal Highway Funds.

MAINE #2

\$14.5 Billion level
ALLOCATION FORMULA

CATEGORICAL PROGRAM DETAIL

| STATE | Total Bridge Cost Share | Lane Miles | | VMT | | Diesel Fuels | Total Allocation | % of Total |
|----------------|----------------------------|------------|------------|----------|------------|-----------------|---------------------|---------------|
| | | Rural | Urban | Rural | Urban | | | |
| ALABAMA | \$24.89 | \$22.56 | \$29.76 | \$24.58 | \$20.80 | \$27.60 | \$150.19 | 2.18% |
| ALASKA | \$2.88 | \$3.09 | \$2.99 | \$2.46 | \$1.94 | \$2.48 | \$15.85 | 0.23% |
| ARIZONA | \$2.88 | \$18.30 | \$22.28 | \$16.03 | \$22.85 | \$17.41 | \$99.74 | 1.45% |
| ARKANSAS | \$14.42 | \$20.97 | \$13.39 | \$14.37 | \$7.75 | \$22.39 | \$93.29 | 1.35% |
| CALIFORNIA | \$37.42 | \$28.49 | \$138.13 | \$59.97 | \$211.31 | \$102.15 | \$577.48 | 8.37% |
| COLORADO | \$11.68 | \$20.10 | \$20.33 | \$12.87 | \$18.53 | \$10.96 | \$94.48 | 1.37% |
| CONNECTICUT | \$51.20 | \$2.77 | \$19.07 | \$7.69 | \$21.65 | \$11.91 | \$114.29 | 1.66% |
| DELAWARE | \$3.39 | \$1.20 | \$2.91 | \$3.41 | \$3.88 | \$3.22 | \$18.00 | 0.26% |
| D.C. | \$9.12 | \$0.00 | \$2.16 | \$0.00 | \$3.78 | \$1.34 | \$16.40 | 0.24% |
| FLORIDA | \$19.08 | \$17.81 | \$85.53 | \$34.63 | \$84.11 | \$44.79 | \$285.95 | 4.14% |
| GEORGIA | \$23.51 | \$26.68 | \$36.66 | \$34.44 | \$36.53 | \$48.25 | \$206.07 | 2.99% |
| HAWAII | \$3.80 | \$0.81 | \$2.74 | \$2.74 | \$5.64 | \$1.32 | \$17.04 | 0.25% |
| IDAHO | \$2.88 | \$17.67 | \$4.26 | \$6.58 | \$2.80 | \$5.78 | \$39.98 | 0.58% |
| ILLINOIS | \$33.72 | \$31.86 | \$57.53 | \$28.93 | \$59.73 | \$44.87 | \$256.62 | 3.72% |
| INDIANA | \$19.55 | \$22.90 | \$31.25 | \$33.48 | \$25.08 | \$36.49 | \$168.75 | 2.45% |
| IOWA | \$20.98 | \$31.53 | \$15.90 | \$16.44 | \$8.77 | \$19.42 | \$113.04 | 1.64% |
| KANSAS | \$22.03 | \$37.59 | \$15.54 | \$14.09 | \$10.17 | \$17.34 | \$116.76 | 1.69% |
| KENTUCKY | \$23.05 | \$19.10 | \$13.62 | \$21.81 | \$14.47 | \$29.45 | \$121.49 | 1.76% |
| LOUISIANA | \$26.56 | \$14.20 | \$22.35 | \$20.18 | \$19.41 | \$21.46 | \$124.16 | 1.80% |
| MAINE | \$7.18 | \$5.98 | \$4.12 | \$9.79 | \$3.40 | \$6.68 | \$37.15 | 0.54% |
| MARYLAND | \$14.87 | \$5.11 | \$22.39 | \$14.99 | \$27.43 | \$18.90 | \$103.69 | 1.50% |
| MASSACHUSETTS | \$59.58 | \$4.06 | \$35.85 | \$9.20 | \$39.38 | \$16.85 | \$164.92 | 2.39% |
| MICHIGAN | \$26.34 | \$27.77 | \$49.80 | \$36.13 | \$52.28 | \$30.53 | \$222.85 | 3.23% |
| MINNESOTA | \$14.38 | \$35.19 | \$25.08 | \$20.11 | \$21.43 | \$19.25 | \$135.45 | 1.96% |
| MISSISSIPPI | \$17.13 | \$19.87 | \$12.87 | \$17.42 | \$7.99 | \$18.50 | \$93.79 | 1.36% |
| MISSOURI | \$46.64 | \$31.81 | \$27.70 | \$25.70 | \$26.27 | \$31.07 | \$189.19 | 2.74% |
| MONTANA | \$6.00 | \$21.07 | \$3.81 | \$7.16 | \$2.27 | \$6.73 | \$47.03 | 0.68% |
| NEBRASKA | \$13.92 | \$26.45 | \$8.68 | \$9.96 | \$5.46 | \$11.67 | \$76.13 | 1.10% |
| NEVADA | \$2.88 | \$12.73 | \$5.81 | \$4.57 | \$5.66 | \$6.71 | \$38.36 | 0.56% |
| NEW HAMPSHIRE | \$6.23 | \$3.77 | \$4.12 | \$6.88 | \$4.05 | \$3.37 | \$28.42 | 0.41% |
| NEW JERSEY | \$50.88 | \$3.71 | \$39.69 | \$12.72 | \$53.06 | \$29.71 | \$189.77 | 2.75% |
| NEW MEXICO | \$3.81 | \$15.23 | \$8.66 | \$10.93 | \$6.62 | \$11.88 | \$57.14 | 0.83% |
| NEW YORK | \$115.33 | \$22.47 | \$68.07 | \$35.41 | \$81.57 | \$40.39 | \$363.24 | 5.26% |
| NORTH CAROLINA | \$23.71 | \$23.12 | \$32.92 | \$37.35 | \$28.99 | \$35.58 | \$181.67 | 2.63% |
| NORTH DAKOTA | \$4.24 | \$25.64 | \$3.13 | \$4.96 | \$1.71 | \$5.28 | \$44.97 | 0.65% |
| OHIO | \$36.11 | \$25.38 | \$56.46 | \$41.13 | \$52.10 | \$50.00 | \$261.16 | 3.78% |
| OKLAHOMA | \$26.72 | \$30.28 | \$21.99 | \$19.03 | \$17.95 | \$22.46 | \$138.44 | 2.01% |
| OREGON | \$6.35 | \$25.79 | \$15.30 | \$16.25 | \$12.61 | \$17.55 | \$93.85 | 1.36% |
| PENNSYLVANIA | \$101.86 | \$27.26 | \$49.42 | \$43.13 | \$49.37 | \$53.87 | \$324.91 | 4.71% |
| RHODE ISLAND | \$2.88 | \$0.46 | \$7.68 | \$1.06 | \$5.49 | \$2.53 | \$20.11 | 0.29% |
| SOUTH CAROLINA | \$9.71 | \$16.82 | \$16.91 | \$23.92 | \$12.63 | \$18.01 | \$98.00 | 1.42% |
| SOUTH DAKOTA | \$5.70 | \$21.79 | \$3.13 | \$5.99 | \$1.70 | \$5.48 | \$43.80 | 0.63% |
| TENNESSEE | \$31.49 | \$20.96 | \$27.46 | \$25.18 | \$25.23 | \$33.33 | \$163.67 | 2.37% |
| TEXAS | \$45.34 | \$67.07 | \$150.51 | \$63.07 | \$113.97 | \$77.14 | \$517.10 | 7.49% |
| UTAH | \$2.88 | \$11.55 | \$9.83 | \$5.95 | \$9.09 | \$8.65 | \$47.95 | 0.69% |
| VERMONT | \$6.47 | \$4.04 | \$1.67 | \$5.02 | \$1.41 | \$2.64 | \$21.25 | 0.31% |
| VIRGINIA | \$25.43 | \$16.40 | \$27.25 | \$31.22 | \$34.24 | \$33.01 | \$167.54 | 2.43% |
| WASHINGTON | \$26.32 | \$19.86 | \$29.37 | \$17.96 | \$29.42 | \$19.71 | \$142.63 | 2.07% |
| WEST VIRGINIA | \$33.18 | \$9.70 | \$5.22 | \$11.74 | \$4.31 | \$10.78 | \$74.93 | 1.09% |
| WISCONSIN | \$20.49 | \$29.19 | \$25.34 | \$26.32 | \$22.23 | \$24.31 | \$147.88 | 2.14% |
| WYOMING | \$2.88 | \$11.85 | \$3.37 | \$5.09 | \$1.47 | \$8.78 | \$33.44 | 0.48% |
| US TOTAL | \$1,150.00 | \$960.00 | \$1,340.00 | \$960.00 | \$1,340.00 | \$1,150.00 | \$6,900.00 | 100.00% |

\$14.5 Billion Level

MAINE #2

ALLOCATION FORMULA

SUMMARY FUNDING

| STATE | Categorical Program | | | Total | Flexible Program | Hold Harmless | Total Funding | % of Total |
|----------------|---------------------|----------|---------|------------|------------------|---------------|---------------|------------|
| | Formula | Half % | 85% MA | | | | | |
| ALABAMA | \$150.19 | | | \$150.19 | \$140.28 | | \$290.47 | 2.028% |
| ALASKA | \$15.85 | \$18.65 | | \$34.50 | \$14.78 | \$104.05 | \$153.34 | 1.070% |
| ARIZONA | \$99.74 | | | \$99.74 | \$111.25 | | \$210.99 | 1.473% |
| ARKANSAS | \$93.29 | | | \$93.29 | \$103.33 | | \$196.61 | 1.373% |
| CALIFORNIA | \$577.48 | | \$39.25 | \$616.73 | \$746.59 | | \$1,363.31 | 9.517% |
| COLORADO | \$94.48 | | | \$94.48 | \$86.38 | | \$180.85 | 1.263% |
| CONNECTICUT | \$114.29 | | | \$114.29 | \$84.66 | | \$198.94 | 1.389% |
| DELAWARE | \$18.00 | \$16.50 | | \$34.50 | \$21.59 | | \$56.09 | 0.392% |
| D.C. | \$16.40 | \$18.10 | | \$34.50 | \$10.57 | \$9.28 | \$54.34 | 0.379% |
| FLORIDA | \$285.95 | | | \$285.95 | \$340.92 | | \$626.87 | 4.376% |
| GEORGIA | \$206.07 | | \$10.50 | \$216.57 | \$262.18 | | \$478.75 | 3.342% |
| HAWAII | \$17.04 | \$17.46 | | \$34.50 | \$17.10 | | \$51.60 | 0.360% |
| IDAHO | \$39.98 | | | \$39.98 | \$31.08 | \$1.93 | \$72.99 | 0.510% |
| ILLINOIS | \$256.62 | | | \$256.62 | \$264.95 | | \$521.57 | 3.641% |
| INDIANA | \$168.75 | | | \$168.75 | \$180.98 | | \$349.73 | 2.441% |
| IOWA | \$113.04 | | | \$113.04 | \$90.03 | | \$203.07 | 1.418% |
| KANSAS | \$116.76 | | | \$116.76 | \$91.48 | | \$208.24 | 1.454% |
| KENTUCKY | \$121.49 | | | \$121.49 | \$127.01 | | \$248.50 | 1.735% |
| LOUISIANA | \$124.16 | | | \$124.16 | \$131.54 | | \$255.70 | 1.785% |
| MAINE | \$37.15 | | | \$37.15 | \$42.08 | | \$79.23 | 0.553% |
| MARYLAND | \$103.69 | | \$2.70 | \$106.39 | \$128.79 | | \$235.18 | 1.642% |
| MASSACHUSETTS | \$164.92 | | | \$164.92 | \$140.22 | | \$305.14 | 2.130% |
| MICHIGAN | \$222.85 | | | \$222.85 | \$229.95 | | \$452.80 | 3.161% |
| MINNESOTA | \$135.45 | | | \$135.45 | \$121.87 | | \$257.32 | 1.796% |
| MISSISSIPPI | \$93.79 | | | \$93.79 | \$95.91 | | \$189.70 | 1.324% |
| MISSOURI | \$189.19 | | | \$189.19 | \$183.02 | | \$372.20 | 2.598% |
| MONTANA | \$47.03 | | | \$47.03 | \$33.97 | \$26.14 | \$107.14 | 0.748% |
| NEBRASKA | \$76.13 | | | \$76.13 | \$51.98 | | \$128.12 | 0.894% |
| NEVADA | \$38.36 | | | \$38.36 | \$38.90 | | \$77.26 | 0.539% |
| NEW HAMPSHIRE | \$28.42 | \$6.08 | | \$34.50 | \$28.88 | | \$63.38 | 0.442% |
| NEW JERSEY | \$189.77 | | | \$189.77 | \$209.63 | | \$399.40 | 2.788% |
| NEW MEXICO | \$57.14 | | | \$57.14 | \$58.28 | | \$115.43 | 0.806% |
| NEW YORK | \$363.24 | | | \$363.24 | \$324.02 | | \$687.26 | 4.798% |
| NORTH CAROLINA | \$181.67 | | \$0.81 | \$182.48 | \$220.91 | | \$403.39 | 2.816% |
| NORTH DAKOTA | \$44.97 | | | \$44.97 | \$25.26 | \$2.09 | \$72.32 | 0.505% |
| OHIO | \$261.16 | | | \$261.16 | \$290.33 | | \$551.49 | 3.850% |
| OKLAHOMA | \$138.44 | | | \$138.44 | \$121.21 | | \$259.66 | 1.813% |
| OREGON | \$93.85 | | | \$93.85 | \$98.03 | | \$191.88 | 1.339% |
| PENNSYLVANIA | \$324.91 | | | \$324.91 | \$322.15 | | \$647.06 | 4.517% |
| RHODE ISLAND | \$20.11 | \$14.39 | | \$34.50 | \$21.54 | | \$56.04 | 0.391% |
| SOUTH CAROLINA | \$98.00 | | | \$98.00 | \$103.50 | | \$201.50 | 1.407% |
| SOUTH DAKOTA | \$43.80 | | | \$43.80 | \$26.82 | \$8.81 | \$79.43 | 0.554% |
| TENNESSEE | \$163.67 | | | \$163.67 | \$166.74 | | \$330.41 | 2.307% |
| TEXAS | \$517.10 | | | \$517.10 | \$525.64 | | \$1,042.74 | 7.279% |
| UTAH | \$47.95 | | | \$47.95 | \$52.29 | | \$100.24 | 0.700% |
| VERMONT | \$21.25 | \$13.25 | | \$34.50 | \$17.87 | \$2.28 | \$54.65 | 0.381% |
| VIRGINIA | \$167.54 | | | \$167.54 | \$193.84 | | \$361.38 | 2.523% |
| WASHINGTON | \$142.63 | | | \$142.63 | \$132.17 | | \$274.80 | 1.918% |
| WEST VIRGINIA | \$74.93 | | | \$74.93 | \$60.22 | | \$135.14 | 0.943% |
| WISCONSIN | \$147.88 | | | \$147.88 | \$142.56 | | \$290.44 | 2.028% |
| WYOMING | \$33.44 | \$1.06 | | \$34.50 | \$34.73 | \$11.62 | \$80.85 | 0.564% |
| US TOTAL | \$6,900.00 | \$105.48 | \$53.27 | \$7,058.75 | \$7,100.00 | \$166.20 | \$14,324.95 | 100% |

DISCUSSION OF THE USE AND TAXATION OF ALTERNATE FUELS IN THE FUTURE

Introduction

The purpose of this discussion paper is to explore the current and projected impact of alternative motor fuel consumptions on the Federal Highway Trust Fund (HTF) and policy options for consideration.

Presently, consumption of alternative motor fuels means direct reductions to the HTF. The table below shows the current and proposed motor fuel tax rates and exemptions.

Highway Excise Tax Structure

| Motor Fuel Type | Existing Exemption-Current Rate | Relative to Gasoline Tax | New Rate 12/01/90 | New Exemption 12/01/90-Relative to Gasoline Tax |
|---|---------------------------------|--------------------------|-------------------|---|
| Gasoline/Special Fuel/Diesohol | \$.09/gal. | — | \$.115/gal. | — |
| Gasohol/Special Fuel with 10% Alcohol | \$.03/gal. | \$.06/gal. | \$.055/gal. | \$.06/gal. |
| Ethanol/Methanol not made from Petroleum or Natural Gas | \$.03/gal. | \$.06/gal. | \$.054/gal. | \$.061/gal. |
| Ethanol/Methanol made from Natural Gas | \$.045/gal. | \$.045/gal. | \$.0525/gal. | \$.0625/gal. |
| Diesel | \$.15/gal. | — | \$.17/gal. | — |

Source: *Transportation Studies Division, FHWA, October 31, 1990*

The Federal Highway Administration estimates that annual losses to the HTF because of these exemptions totaled \$500 million in 1989. Alternative fuel use in 1989 represented approximately 5 percent of total gasoline consumption.

Major Issues

Conflicts exist between the major national objectives of environmental quality, national security, and transportation infrastructure. These conflicts were underlined by proposed amendments to the Clean Air Act in the last days of the most recent session of Congress. The current Middle East situation and the long-term perspective on gasoline prices also suggests the desirability of alternative fuel use for transportation. However, existing incentives rely heavily on motor fuel tax exemptions from a portion of the federal excise tax on motor fuel, which directly effects the funds available to build and maintain the nation's highways.

Environmental—Three proposed amendments to the Clean Air Act relating to the level of oxygenated fuel in non-attainment areas were presented in 1990. Each proposal had fiscal impacts on the HTF.

Final provisions require 2.7 percent oxygen content and are estimated to reduce payments to the HTF by \$700 million, in addition to the \$500 million already lost.

National Security—The dependence of transportation in the United States on petroleum is perceived by many to be a national security concern. Currently, only 3 percent of transportation energy can be supplied by non-oil sources, compared to over 20 percent in other industrial sectors.

The Switch to Alternative Fuels

Price is the determining factor in the development of alternative fuels. The following table lists the major alternative fuels and estimates the trigger price at which they can be produced without subsidy.

| Fuel Type | Competitive Production In Terms of Cost of Oil Purchased (1988 dollars) |
|--|---|
| Natural Gas | \$15 to \$30 per barrel of oil |
| Methanol conversion from surplus | |
| natural gas and other petrochemical sources | \$25 to \$35 per barrel of oil |
| Methanol conversion from biomass, | \$40 to \$150 per barrel of oil |
| Methanol conversion from corn-based ethanol | |
| (with advances in technology) | (\$35 per barrel) |
| Electricity | \$20 per barrel |
| Petroleum like fluids from coal | \$50 to \$70 per barrel |
| Petroleum like fluids from oil shale (with advances in technology) | (\$35 per barrel) |

Source: *TRB 2020 Report*, Page 225.

The trigger prices in the preceeding table show lower and upper bounds in terms of price per barrel of crude oil.

Natural gas fuels and methanol conversion from surplus natural gas and other petrochemical sources are becoming economically competitive at current crude oil prices. However, use of most of these fuels also requires special distribution networks, storage facilities and vehicle conversion, which are not in place and require a significant investment.

Other potential sources not listed include Hydrogen and Solar Power. Each of these sources are in the early stages of development and definitive costs have not yet been established.

Issue and Options

Issue: If fuel tax exemptions remain in law, the reduced payments to the HTF will continue and may increase due to a number of factors including:

- 1) Further environmental initiatives;
- 2) Additional demand induced by higher gasoline prices; and,
- 3) Further energy independence initiatives.

Option(s) (for discussion):

- 1) Eliminate exemptions—allow market forces to provide incentives for alternative fuel production. Higher oil prices will make alternative fuel competitive;
- 2) Eliminate exemptions from HTF—allow for tax credit from General Fund for alternative fuel use based on environmental and national security objectives; and,
- 3) Maintain exemptions—allow for other alternative fuels to be included based on environmental and national security objectives.

Issue: Some potential alternative fuels are not currently taxed or are not physically in a form that allows them to be taxed on a per gallon basis.

Option(s) (for discussion):

- 1) Establish a British Thermal Unit (BTU) charge based on energy content; and,
- 2) Establish an Ad Valorem tax on all fuels at the retail level.

THE 1990 NATIONAL HIGH SCHOOL ESSAY CONTEST WINNER

A Word from the 1990 President of the American Association of State Highway and Transportation Officials...

Kermit Justice
Secretary
Delaware Department of Transportation

*T*ogether we have built the finest transportation system in the world, in which we can take great pride. The future of that system, and of our nations, lies not within our hands, but in the hands of our youth. And we take great pride in them as well.

The entries in the 1990 AASHTO Transportation Essay Contest demonstrate an awareness of our transportation needs and an appreciation of the importance transportation will play as America enters the next century. I congratulate the winner, whose work is presented here, and all the young people across the nation who took part.

GRAND PRIZE WINNER

Janel Erica Stricker
Scottsbluff Senior High School
Scottsbluff, Nebraska

"Our community's future is at stake...Without meeting transportation needs, we cannot expect to create jobs, bring in industry, keep our young people, and experience economic and social growth."

We live in a global society in which we must be able to communicate and travel. We can no longer live with the isolation of past and present experience, because the people we deal with are all over the world. Our mobile society requires that we have ready access to good transportation in order to travel across states, nations and oceans.

The transportation system now in place is good, but like everything else in today's world of modern technology, it can rapidly become antiquated. It is vital that what is now in place be taken care of and updated. The present system can be the base for new and advanced technology to meet the increased demand of the traveling public and the business world.

The present interstate system was built on a plan with a vision for the future. The interstate system has been completed, but a new plan with another vision for the future must now be put into effect which will address future highway needs to keep America moving. The new plan must incorporate a vision of connecting rural American communities to the mass transit systems of metropolitan America.

Transportation is, indeed, the key which will move our people and our economy forward. In fact,

it has always been the key which helped build America into a world leader. Without transportation, economic growth would cease. We rely on transportation for economic prosperity, not only on a national and international level, but on a local level as well.

As an example, let me share what is happening in my own community to illustrate why transportation will continue to be vital in keeping America strong, and why it is important not to overlook the rural needs of America.

We are located in rural America, western Nebraska to be exact. Our own eastern Nebraska counterparts refer to us as "outstate". Headlines recently indicated that this land should be returned to the buffalo. The *Lincoln Star* reported that our long sought after four-lane expressway would only be a "highway to nowhere".

To some, that is an indication of how bleak our economy is due to lack of industry to revitalize our community. However, our number one detriment in attracting new industry is lack of accessible transportation. Industry is interested in locating here until they learn of our inadequate mobility. Industry sees my community as being cut off—isolated from the rest of the state. The nearest interstate is 40 miles to the south of us, and industry will not put their trucks on a 40 mile stretch of road of which 27 miles are impassable. In an effort to remedy this situation, a full-fledged effort is now in progress to build a four-lane expressway which will connect us to the interstate system 40 miles away. Long-range four-lane expressway plans would eventually link us to the interstate system 200 miles to the north.

It is not just the network of surface transportation that presents a dilemma to my community; air transportation is also a factor which affects the economic growth of western Nebraska. The discontinuation of the flight service station is a step backwards in rural transportation. Western Nebraska has been stripped of a feature that enhances air transportation and the safety thereof. The community is battling to retain Essential Air Service which will play an important role in economic growth. Our rural community and the surrounding areas are in need of reliable and safe air transportation with reasonable rates if we are to develop economically. For the most part it costs as much to fly across the state of Nebraska from Scottsbluff as it does to fly across the country from one metropolitan city to another. These present needs must be addressed now with a plan that will take care of future transportation needs as well.

Our community's future is at stake because transportation needs are not being met. When this situation is repeated time and again across rural America, I see America's future, as a whole, in jeopardy. Transportation needs must be met on a local level as well as on a state and federal level.

Another scholarship application requires a written essay on "How Can We Keep the Smart and Talented Students from Going to Other Places to Work?" I feel the two essay topics are related, especially in rural America. Western Nebraska finds it difficult to retain its young people because of the lack of job creation and industry. Yet without meeting transportation needs, we cannot expect to create

jobs, bring in industry, keep our young people and experience economic and social growth. The end result: part of rural America dies again. How often can this happen before the heart of America is adversely affected?

Nebraska Governor Kay Orr said, "Highways are responsible for supplying economic nutrients throughout rural America...It was not our wealth that made our highways possible, but our highways that made our wealth possible."

I have brought the importance of future transportation home to a local level to illustrate why it is really the number one factor which will help rural America meet the challenges of the future. But beyond my isolated surroundings is the rest of the state, the country, and the world. All have similar needs which must be met in order to survive and continue to grow.

To be a world leader, the United States must tend to all needs—rural and metropolitan—of all modes of transportation available: highways, airways, railways, and waterways. Our mobile society requires a technically advanced transportation network to successfully compete and communicate world-wide. Until these needs are met, our economic growth will be stifled.

Bibliography

1. *Lincoln Star*, December 10, 1988, p. 10
2. *Omaha World Herald*, August 25, 1988, p. 23

